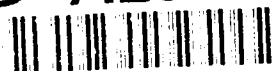


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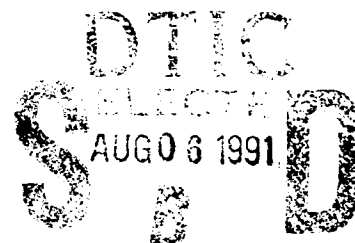


NWC TP 7019
Supplement

**A WATER GEOCHEMISTRY STUDY OF INDIAN WELLS VALLEY,
INYO AND KERN COUNTIES, CALIFORNIA
Supplement. Isotope Geochemistry
and Appendix H**

by
James A. Whelan
Geothermal Program Office
Public Works Department

SEPTEMBER 1990



**NAVAL WEAPONS CENTER
CHINA LAKE, CA 93555-6001**



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Naval Weapons Center

FOREWORD

This report documents a water geochemistry study performed to determine possible sources of leakage of geothermal waters into the Indian Wells Valley. The study reported on here was partially funded by a grant from the Eastern Kern County Resource Conservation District. This document is being published as a technical report by the Geothermal Program Office to make the information part of the permanent record of the Department of Defense. Any reference to company or product names does not constitute endorsement by the U.S. Navy.

This supplement is in addition to the original two volumes published in September 1989. Volume 1 contains the main body of the report and Appendix A; Volume 2 contains Appendixes B through G.

This supplement was reviewed for technical accuracy by Carl F. Austin, NWC; James Moore, California Energy Co.; and Robert O. Fournier, United States Geological Survey.

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27 September 1990

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Released for publication by
W. B. PORTER
Technical Director

NWC Technical Publication 7019, Supplement

Published by.....Technical Information Department
Collation Cover, 28 leaves
First printing..... 150 copies

REPORT DOCUMENTATION PAGE

Form approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE September 1990	3. REPORT TYPE AND DATES COVERED Supplement to September 1989 Final
4. TITLE AND SUBTITLE A Water Geochemistry Study of Indian Wells Valley, Inyo and Kern Counties, California, Supplement. Isotope Geochemistry and Appendix H (U)			5. FUNDING NUMBERS Prog. Element No. 63724N Project No. R0829 Work Unit No. 520A
6. AUTHOR(S) Whelan, James A.			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Weapons Center China Lake, CA 93555-6001			8. PERFORMING ORGANIZATION REPORT NUMBER NWC TP 7019, Supplement
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Weapons Center China Lake, CA 93555-6001			10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT A Statement; approved for public release; distribution is unlimited			12b. DISTRIBUTION CODE
13. ABSTRACT (Maximum 200 words) (U) Hydrogen and oxygen isotope data on waters of Indian Wells Valley, the Sierra, Rose Valley, and Coso thermal and nonthermal waters were studied. (U) The isotope ratios of Sierran waters are a function of latitude with both ratios becoming depleted in the heavier isotopes from south to north. Assuming that groundwater recharge is from the Sierra, recharge areas for the various groundwater types can be designated. (U) Hydrogen and oxygen isotopes do not uniquely define the recharge area for the Coso geothermal system but strongly suggest Sierran recharge with perhaps some local recharge. Sierran recharge is best supported by structural features and stream flow characteristics in the Sierra. Coso geothermal brines may have a component of waters from several different past pluvial periods, but the volume and midfield recharge rate of the system suggest continuous recharge.			
14. SUBJECT TERMS Geochemistry Groundwater Geothermal Isotopes			15. NUMBER OF PAGES 54
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT

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INTRODUCTION

This supplement to NWC TP 7019 documents what is known about the isotope geochemistry of groundwaters in Indian Wells and Rose Valleys, the local Sierran groundwaters and surface waters, and thermal and nonthermal waters of the Coso Range, based on studies by the NWC Geothermal Program Office on the groundwater hydrology of these areas. Results of chemical studies are given in Volumes 1 and 2 of this report. General data on the geography and geology of the study area are given in Volume 1.

Isotope geochemistry is another tool that may provide additional knowledge of sources and flow paths of groundwater and their changes with time. Definitions and theory are given in the following section.

ISOTOPES

In a gross sense, atoms of an element are made up of three particles—protons, electrons, and neutrons. The electrical charge of protons is positive, and that of electrons is negative. Neutrons have no electrical charge. The number of protons determines what element an atom is and gives it its atomic number. In a neutral or nonionized atom the number of electrons equals the number of protons. The most common form of the element carbon is given an arbitrary weight of 12.00. It consists of six protons, six electrons, and six neutrons. Protons and neutrons each have a weight of one. Electrons are essentially weightless. Within limits, the number of neutrons in an atom of an element may vary. Thus, there are carbon atoms with weights of 10, 11, 12, 13, and 14. These varying weights of carbon are called isotopes of carbon.

Water is composed of two elements, hydrogen (H) and oxygen (O) combined as H_2O . There are hydrogen atoms with a weight of one (normally just called hydrogen), two (commonly called deuterium (D)), and three (commonly called tritium (T)). Tritium is radioactive. Hydrogen one and deuterium are stable. All hydrogen isotopes occur naturally. Oxygen has isotopes with weights of 15, 16, 17, 18, and 19. Oxygen 16, 17, and 18 are stable and occur naturally. Hydrogen, deuterium, and oxygen 16 and 18 are the isotopes used in this study. The isotope ratios were determined by the U.S. Geological Survey; by the Geology and Geophysics Department, University of Utah for the Eastern Kern County Resource Conservation District (EKCRCD); and by the Stable Isotope Laboratory, Southern Methodist University, for the California Energy Company.

PREVIOUS STUDIES

The first significant study of isotope geochemistry of the area was done by the U.S. Geological Survey partially supported with Navy funds. Fournier and Thompson (1980) published the study as an open-file report. Fournier and Thompson sampled thermal and nonthermal waters from the Coso Range, Dirty Socks Hot Spring, and springs, wells, and surface waters from Rose Valley, and from Big Pine Meadow north to Wild Rose Ranch (formerly the Sam Lewis Ranch) in the Sierra. Waters were also sampled from selected wells at NWC. Fournier and Thompson concluded that the recharge of the Coso Geothermal Field is derived from the portion of the Sierra Nevada generally to the west of the Coso Range.

The EKCRCD supported the geochemical and isotope studies of waters of Indian Wells Valley conducted by the Department of Geology and Geophysics, University of Utah. With EKCRCD permission, the results of the geochemical studies were included with the results of Navy studies in Volumes 1 and 2 of this technical report. The results of the isotope studies were presented to the EKCRCD by Bowman (1988) in an unpublished report.* Bowman reported on surface waters and well and spring waters from the Sierra from Nine Mile Canyon to Freeman Canyon and from various wells in the Indian Wells Valley. One well was sampled in Searles Valley. Bowman concluded that without seasonal sampling of precipitation at selected sites in the Sierra and Indian Wells Valley, and without better knowledge of the depths from which various wells were producing, it was not possible to identify specific areas of recharge for individual wells in Indian Wells Valley. However, he noted that a geothermal component is present in the Red Hill-Little Lake-Lumber Mill-Brown Road waters (warm springs occur in Little Lake).

As part of their continuing studies of the Coso Geothermal Field, California Energy Company, the operator of the field, has had isotope determinations made on 23 water samples from 16 wells. The California Energy Company has given the Navy permission to utilize its data in this study.

Williams and McKibbin (1990), using the data of the California Energy Company and new data, have written a voluminous paper in which they interpret all chemical and isotopic data available on the Coso Geothermal Field. They preferred to conclude that the recharge of the Coso Geothermal system could be rainfall and snowfall in the Coso and Argus Ranges. They also noted that the pattern "could indicate recharge from any nearby region of similar overall elevation." Thus, their data were not absolutely definitive as to the area of recharge for the Coso Geothermal Field. They also concluded that the oxygen isotope ratios indicated "a high degree of water-rock interaction at high temperatures and moderate water/rock ratios." They postulate leakage of geothermal fluids into Coso Wash in the vicinity of the resort area (see page 34 Volume 1). Sulfur isotopes are concordant with those of the granitic Sierran host rocks and indicate little if any sedimentary contribution. They noted that "oxidized and reduced sulfur are far from equilibrium at reservoir conditions. This implies very recent mixing and/or disequilibrium production near to or within the reservoir." They also conclude that carbon isotope ratios are concordant with gases of igneous or clastic sedimentary rocks but that there is no significant contribution of organic or marine carbonate carbon. They noted that there are two areas with steam caps; and from chemical data, concluded that there are regional differences in the source rocks and that convective mixing is slower than the processes creating the differences.

Buchanan (1989) proposed a theory, based on isotopic evidence, that recharge of geothermal systems in Utah and Nevada comes from "Paleo-fluid (Pleistocene - 8000 to 12000 years before present) recharge"; this theory is difficult to reconcile with the pattern of pluvial events that have affected this region.

The purpose of this supplement to NWC TP 7019 is to review available data and to determine what we have learned from isotopic data to date that may be of local significance.

* Bowman, J. R. 1988. *Stable Isotope Analysis of Ground Waters of Indian Wells Valley and Vicinity - Preliminary Results*. Unpublished Report to EKCRD. 7 p.

DISCUSSION

Fournier and Thompson (1980) give a good but simple discussion of isotopic fractionation in waters.

The concentrations of the stable isotopes of oxygen and hydrogen in water are generally expressed in terms of $\delta^{18}\text{O}$ and δD , where

$$\delta^{18}\text{O} = \frac{(^{18}\text{O}/^{16}\text{O})_{\text{sample}} - (^{18}\text{O}/^{16}\text{O})_{\text{standard}}}{(^{18}\text{O}/^{16}\text{O})_{\text{standard}}} \times 1000 \quad (1)$$

and

$$\delta\text{D} = \frac{(\text{D}/\text{H})_{\text{sample}} - (\text{D}/\text{H})_{\text{standard}}}{(\text{D}/\text{H})_{\text{standard}}} \times 1000 \quad (2)$$

and the standard is usually mean ocean water (SMOW). Craig (1961) found that on a plot of δD vs $\delta^{18}\text{O}$, meteoric waters from throughout the world lie close to a straight line given by the equation,

$$\delta\text{D} = 8\delta^{18}\text{O} + 10 \quad (3)$$

This straight-line relationship comes about because ocean water is the source of most of the water vapor that precipitates over landmasses.* When ocean water evaporates, the lighter isotopes of oxygen and hydrogen are preferentially partitioned into the vapor phase. Because the reservoir of ocean water is very large compared to the amount of water vapor in the atmosphere at any given moment, and because most rain water eventually returns to the ocean, the isotopic composition of the ocean remains relatively constant. Over long periods of time, however, there are small but significant changes in the isotopic composition of ocean water as the amount of water tied up in polar ice caps changes. When and where the water vapor condenses and precipitates, the heavier isotopes in the vapor partition preferentially into liquid droplets (rain) and ice (snow). This leaves the remaining vapor relatively depleted in D and ^{18}O so that the last rain that falls from a given initial quantity of vapor will be isotopically lighter than the first rain that falls from that vapor. The partitioning or fractionation of light and heavy isotopes between vapor and liquid is also temperature dependent: the lower the temperature of the reaction, the greater the fractionation. The processes that control the concentrations of stable isotopes in precipitation are presented by Dansgaard (1953, 1964), Ehhalt and others (1963), Friedman and others (1964), Craig and Gordon (1965), and Stewart and Friedman (1975). The net result of these processes is that rain water falling from a given storm becomes isotopically lighter as the storm moves inland, and rain (or snow) that forms at colder temperatures (high elevations and latitudes closer to the poles) is lighter than rain that forms at higher temperatures. Although the isotopic composition of rain that falls in a given region will be different for each storm, the average over a

* This assumption could easily founder, however, on the problems of "lake effects" given major stands of water in the San Joaquin Valley, either fresh or saline, and major stands of water in the basins east of the Sierra during the past 14 identified pluvial events (Whelan footnote).

long period of time remains relatively constant. The isotopic composition of ground water reflects that average.

Smith and others (1979) measured the deuterium concentrations in rain and snow at 26 stations in California and Nevada during the exceptionally wet 1968-69 season.* They showed that the winter precipitation upon the Sierra Nevada was isotopically slightly lighter than the summer and fall precipitation on the nearby Mojave Desert. Most of the Sierra ground water recharge comes from winter storms moving generally from west to east.** These winter storms drop most of their moisture before reaching the Coso Range. In contrast, most of the Coso Range recharge is from large, but infrequent tropical storms that come from the south. On the basis of these data, we expected the isotopic composition of the normal, non-thermal ground water in the vicinity of the Coso geothermal field to be different from the isotopic composition of nearby Sierran waters. The purpose of the present study was to determine if variations in isotopic composition of ground waters in the region around Coso indicate whether the recharge for the Coso geothermal system comes from precipitation on the Sierra Nevada or from local precipitation at Coso.

More detailed explanations are given by Faure (1986, Chapter 2), O'Neil; Cole and Ohmoto; Gregory and Criss; and Sheppard (all 1986).

Fournier and Thompson (1980) sampled waters of the Sierra, Rose Valley, and thermal and nonthermal waters of the Coso Range in addition to some miscellaneous waters. At that time there were only two sites at which Coso reservoir waters could be sampled: well Coso No. 1 in the resort area (samples CF-79-1 and CF-79-2) and Coso Geothermal Exploration Hole No. 1 (CGEH No. 1) (samples CC-77-4 and CF-78-1).

Both the waters of the Sierra and the nonthermal waters of the Coso Range have isotope ratios, which on a plot of isotope ratios, plot close to the meteoric line (Figure 1). The waters from each locality occupy distinct fields on the plot with no overlap. The Coso waters have less negative δD values and generally less negative $\delta^{18}O$ values than do the Sierran waters.

Oxygen is much more abundant than is hydrogen in rock-forming minerals. Therefore, when meteoric waters react with hot rocks, oxygen exchange dominates; and on a standard isotope ratio plot the shift is away from the meteoric line, essentially horizontally, with $\delta^{18}O$ values becoming less negative. The magnitude of this horizontal shift increases with temperature, but depends also on the $\delta^{18}O$ value of the rocks and residence time of water in a given reservoir (Faure 1986, pp. 450-51). The CGEH No. 1 waters are horizontally displaced toward less negative $\delta^{18}O$ values from the area containing the Sierran waters. The deep Coso No. 1 water lies horizontally away from the Coso nonthermal waters, which could indicate all or some local recharge. However, all four points (the two CGEH No. 1 samples and the Coso No. 1 deep and shallow waters) lie on a line with a positive slope of about 50 degrees. This could be an evaporative effect line (see Figure 1). Fournier and Thompson (1980) feel that the shallow Coso No. 1 sample

* This was a westerly storm series (Whelan footnote).

** This assumption requires much more analysis, as the position of the Pacific High determines the temperature of storms and their direction. Thus, some winters, especially very wet ones, present a totally different weather pattern that would affect isotope ratios (Whelan footnote).

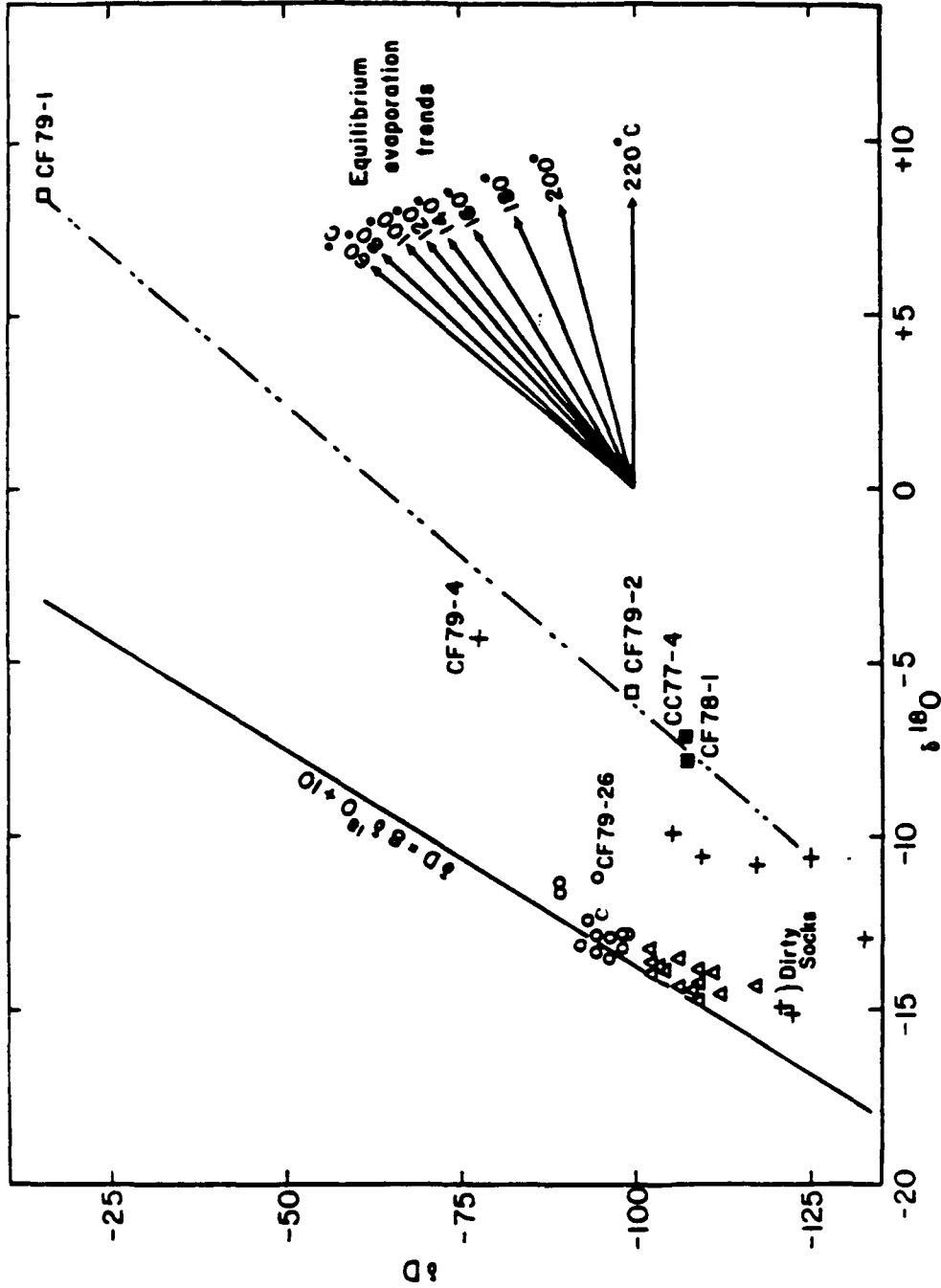
represents the deep Coso No. 1 water affected by evaporation. The chemistry of Coso No. 1 deep and the CGEH No. 1 samples strongly suggest that they are the same water. Thus, Fournier and Thompson concluded:

The δD value of CGEH No. 1 water supports the view that recharge for the hydrothermal system comes from the Sierra Nevada to the west and that little or no component of the recharge comes from the Coso Range. However, the data do not rule out the possibility that recharge is a mixture of isotopically light Sierra water from the north with some isotopically heavy locally derived Coso Range water. The isotopic data do show that recharge for the CGEH No. 1 thermal water could not be from locally derived ground water, nor could it be from Owens Lake which is isotopically very heavy because of extensive evaporation (Friedman and others, 1976).

In 1986 Rob Baskin and David Turner, both University of Utah graduate students, sampled springs, wells, and surface waters for chemical and isotope analyses, respectively. Unfortunately, while collecting samples independently, their sampling numbering system became confused. Table 1 shows how their numbering systems correlate. The sample numbers of Baskin are used on the chemical analyses published in Volume 2 of this technical report (Appendix E). The University of Utah study was supported by the EKCRCDC. The chemical studies were incorporated into Volume 1 of this technical report. The results of the isotope study were furnished to the EKCRCDC in an unpublished report by Dr. John R. Bowman, Professor of Geology, University of Utah. Table 1 gives the results of his analyses.

Baskin and Turner sampled alpine waters from the crest and eastern flank of the Sierra from Kennedy Meadows south to Walker Well in Freeman Canyon. The overlap of the sampling sites of Baskin and Turner and Fournier and Thompson allowed a comparison of the results of the two laboratories. On samples run by both laboratories, the results were nearly identical. For isotopic studies, some Navy wells were sampled for which chemical analyses of the water were not previously published in this series. These analyses are given in Appendix H.

The University of Utah isotopic analyses of alpine waters also fell along the meteoric line on the standard isotope ratio plot but expanded the Sierran field considerably (Figure 2). The Sierran field using Bowman's data now covers most of the Sierran field of Fournier and Thompson (1980), and the field containing the nonthermal waters of the Coso Range (Figure 2). Thus, the isotopes of hydrogen and oxygen do not uniquely define the recharge area of the Coso geothermal system (Figure 3).



Circles represent non-thermal waters from the Coso Range, triangles represent non-thermal waters from the Sierra Nevada Mountains and Rose Valley. Solid squares represent waters from the CGEH No. 1 well; open squares represent waters from the Coso No. 1 well, crosses represent other thermal waters and steam condensates. (Modified from Fournier and Thompson, 1980.)

FIGURE 1. $\delta D - \delta^{18}O$ Relations for Thermal and Non-Thermal Waters From the Coso Region.

Whelan plotted δD and $\delta^{18}O$ of the alpine samples against the distance south of Coso Junction (Figures 4 and 5). Values of δD generally become less negative as one goes south from Coso Junction. Values of $\delta^{18}O$ behave in a similar manner. This systematic variation is probably the result of a combination of a latitude effect and an altitude effect. The average elevation of the Sierra increases to the north from Walker Pass. This increase in elevation will decrease the mean air temperature, which tends to make the $\delta^{18}O$ of the precipitation (mainly snowfall) more negative. A good discussion of the latitude and temperature effects is given on pages 434 and 435 of Faure (1986). In both cases it was possible to fit a linear least squares (best fitting) line to the data with good fits. The formulas for these lines are

$$\delta D = -107.8 + 0.81m$$

$$r^2 = 0.72$$

$$\delta^{18}O = -14.32 + 0.10m,$$

$$r^2 = 0.66,$$

where

m = miles south of Coso Junction and

r^2 = regression coefficient (0.00 = no correlation; 1.00 = perfect correlation)

The fact that there is some scatter is not surprising. Samples were collected from various types of sources—springs, wells, and streams—and at different elevations relative to the ridge line. Because of this fact, regression coefficients of 0.66 and 0.72 are considered quite good. These regression coefficients would give correlation coefficients of +0.81 and +0.85, respectively (a -1.00 correlation coefficient represents perfect correlation with the line having a negative slope; a +1.00, perfect correlation with a positive slope; and 0.00, no correlation). If one makes the assumption that the recharge areas for the various groundwater types are the Sierra—based on surface geology, regional hydrologic gradient, and flow models—then possible areas in the Sierra can be assigned as recharge areas for the various water types based on isotopic composition.

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TABLE 1. Hydrogen and Oxygen Isotopic Compositions of Waters,
Indian Wells Valley and Vicinity.
(Modified from Bowman, 1988)

Sample No.		δD	$\delta^{18}O$	Location
(Turner)	(Baskin)			
1.	IWV 1	-109	-14.4	Kennedy Meadows well
1b.		-103	-14.0	Kennedy Meadows surface
2.	IWV 18	-101	-13.4	Chimney Peak Forest Service Fire Station well
3.	IWV 2	-105	-13.6	Genesis Minerals well from holding tank
4.	IWV 3	-93	-12.8	C. F. Austin well
5b.	IWV 4	-90	-11.0	Hi-Peak Tungsten Mine water
6.	IWV 5	-94	-13.1	Beckman Spring
7.	IWV 6	-104	-13.4	Leroy Marquardt well
8.	IWV 7	-91	-11.8	John German well
9.	IWV 8	-99	-12.9	Desert Construction well
10.		-89	-12.3	Ben Widtfeldt well
11.	IWV 9	-93	-11.2	Louisiana Pacific Lumber Mill well
12.	IWV 10	-83	-10.8	Sand Canyon stream
13.	IWV 11	-89	-12.5	Walker well, South Valley
14.	IWV 14	-96	-13.1	Gene Edwards well
15.	IWV 12	-97	-12.4	Little Lake Spring, upper
16.		-113	-15.6	L. A. aqueduct
17.		-94	-10.8	Little Lake surface, middle
18.		-95	-11.1	Little Lake surface, lower
19.	IWV 13	-105	-14.2	Little Lake Ranch well
20.	IWV 15	-92	-12.0	Brown Rd. turn well
21.	IWV 16	-92	-12.2	Conrad Neal well
22.		-102	-14.0	Cerro Coso Comm. College holding tank
23.		-104	-13.8	Community well, S. Ridgecrest
24.		-95	-13.5	Griffin well, S. Ridgecrest
25.		-102	-13.8	Charles Smith well, S. Ridgecrest
26.	IWV 17	-84	-12.0	Indian Wells Canyon stream
27.	IWV 21	-89	-12.2	Nine Mile Canyon stream at Chimney Peak Meadows
28.		-94	-13.2	Nine Mile Canyon stream
29.		-88	-12.4	Pearsonville well
30.		-98	-11.5	Brady's Restaurant well
31.		-96	-13.4	Navy well #18B
32.		-97	-13.4	Navy well #29
33.		-92	-12.7	Navy well #15
34.		-99	-13.6	Navy well #27
35.		-95	-12.5	Navy well #B4
36.		-89	-12.5	Navy well #C
37.		-105	-14.5	Well at Ridgecrest Blvd. and Jack's Ranch Rd.
38.		-88	-11.4	Well in Searles Valley

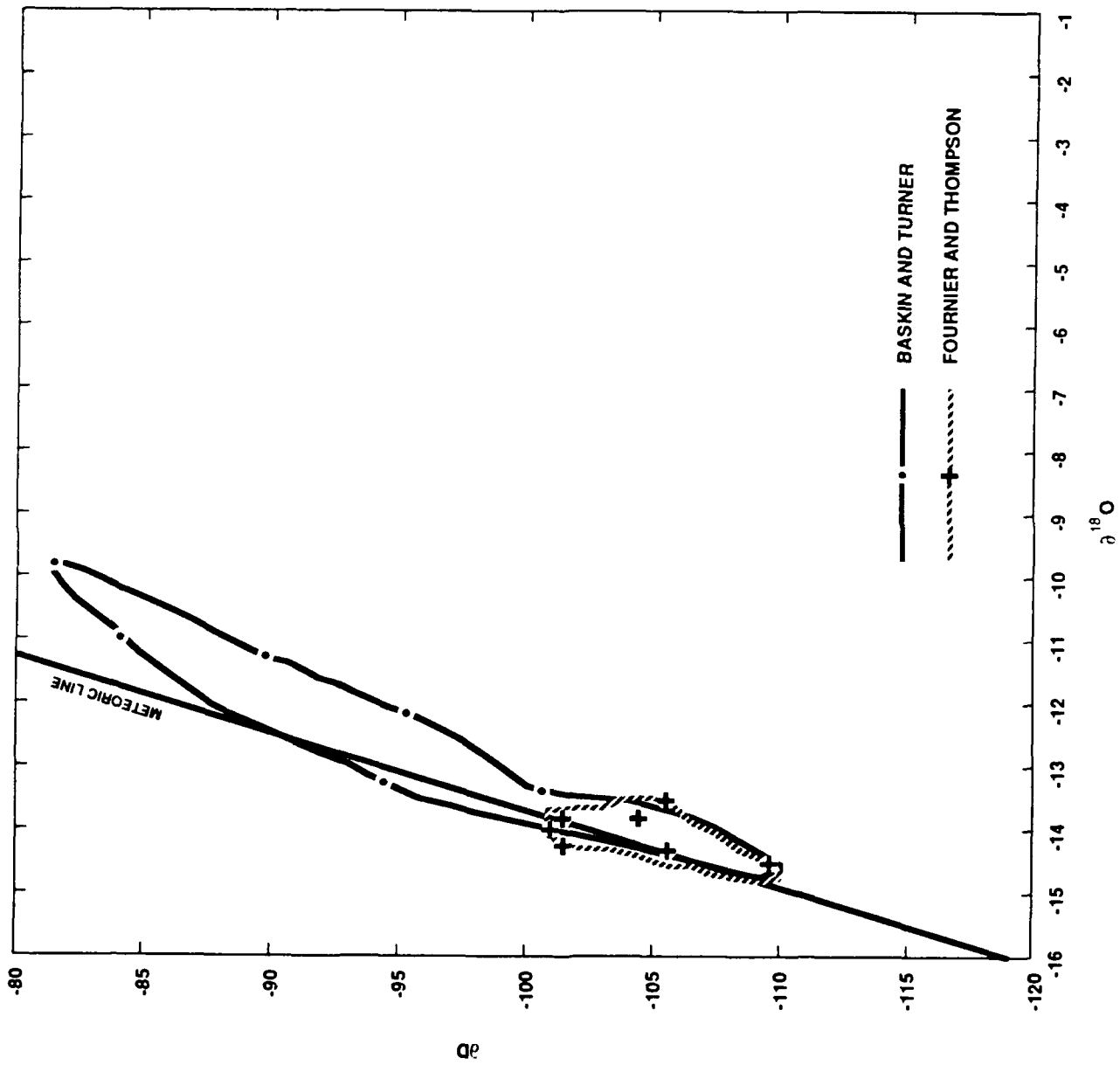


FIGURE 2. δD Versus $\delta^{18}O$ Ratios, Sierran Waters.

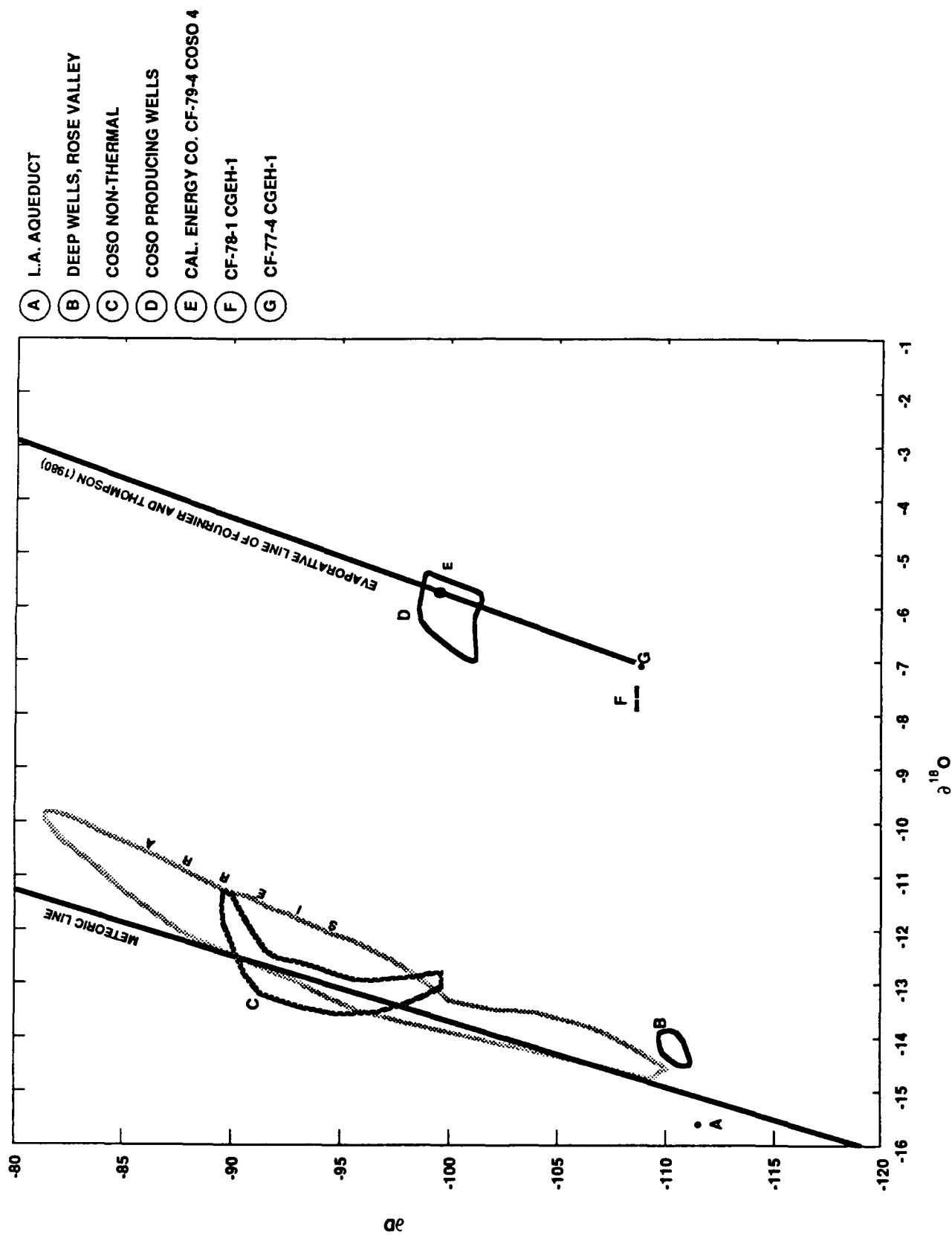


FIGURE 3. δD Vs $\delta^{18}O$ For Various Water Types.

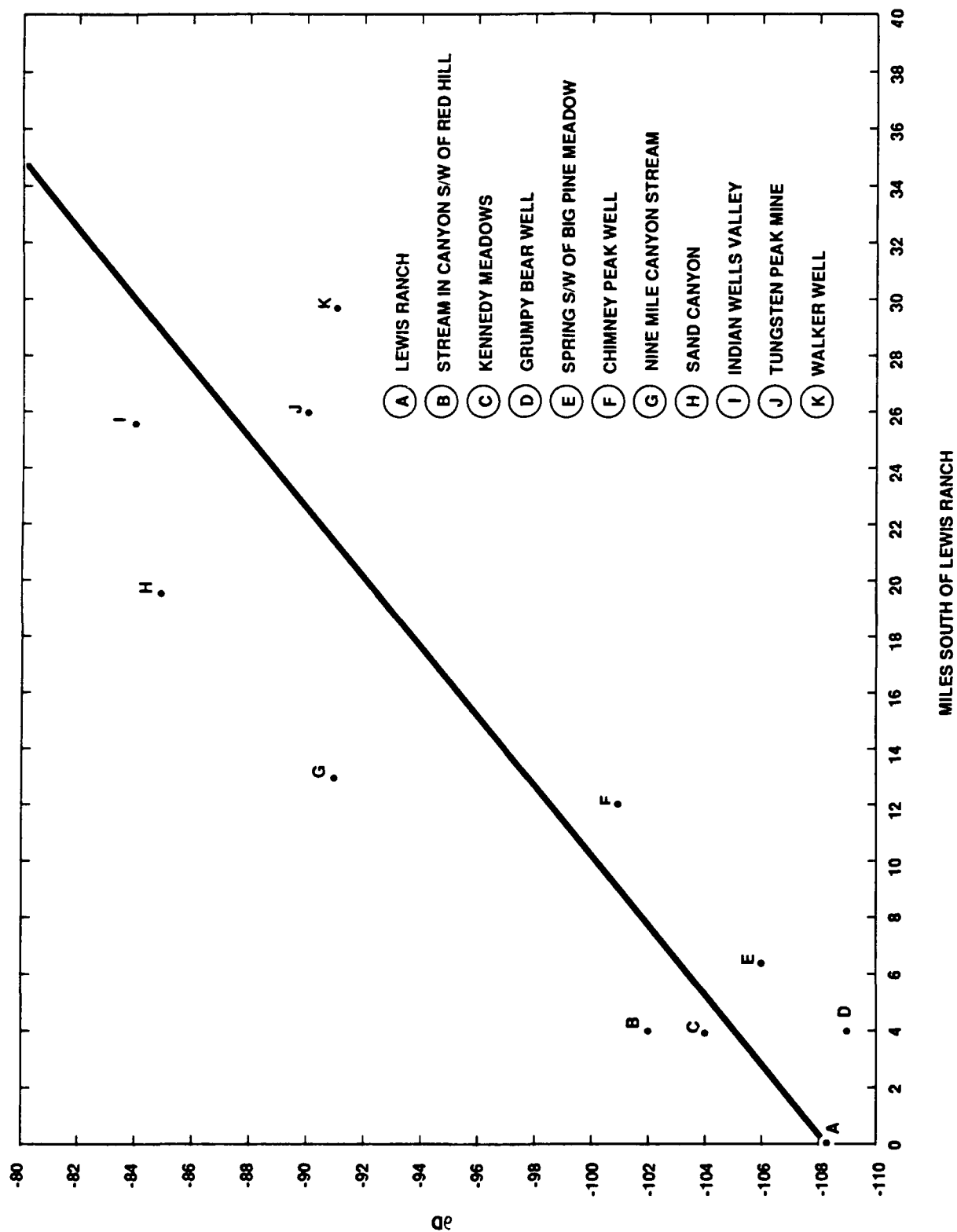


FIGURE 4. δD Relationship to Distance South of Lewis Ranch (Alpine Waters).

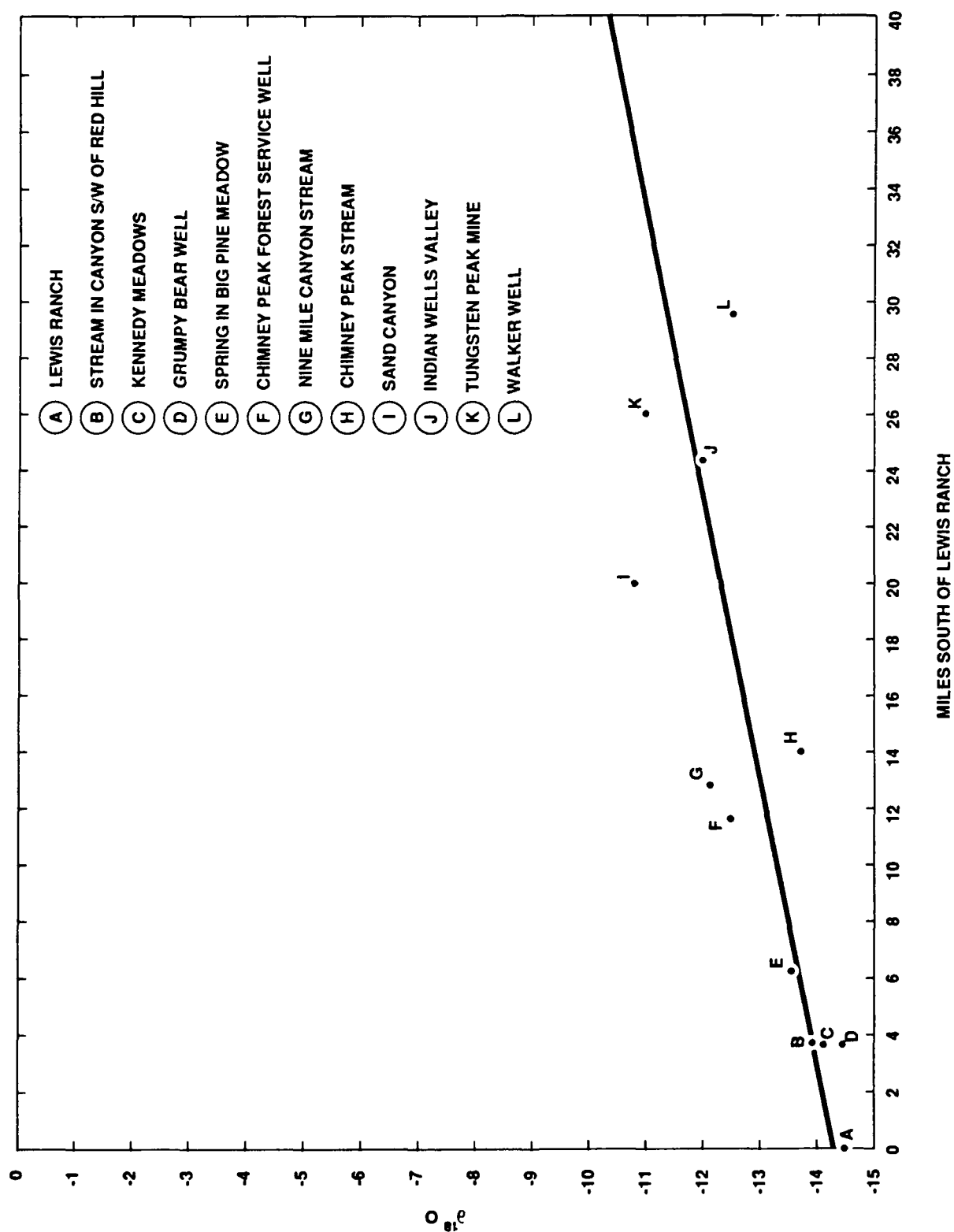


FIGURE 5. $\delta^{18}O$ Relationship to Distance South of Lewis Ranch (Alpine Waters).

The recharge area for the Rose Valley groundwaters is shown in Figure 6.* The Rose Valley recharge area would be the western side of the Sierra from about a mile south of Little Lake to about 5 miles north of Coso Junction. This corresponds almost exactly to the geographic limits of the valley and matches the listric fault-s slump pattern geometry of the Sierran surface.

From Red Hill in southern Rose Valley, through the springs and wells at Little Lake to the well at Linnie Siding (the site where the lumber mill used to be) to where Brown Road turns from north-south to east-west, the groundwaters are complex but give characteristic modified Stiff Diagrams. Sodium is the dominant cation where carbonate-bicarbonate and chloride are the most significant anions (see pages 32 and 33 of Volume 1). These waters represent a mixture of alpine waters and a small amount of Coso Geothermal brines. The Red Hill to Brown Road recharge would come from the Sierra due west of Red Hill south to the Sierra due west of where Brown Road intersects U.S. Highway 395 (Figure 7).

The results for the sulfate waters from two wells and the Tungsten Peak Mine are not as definitive (Figure 8). Deuterium data give a rather limited recharge area between Short Canyon and halfway between Noname and Sand Canyons, while oxygen isotopes would indicate the recharge area to be from Nine Mile Canyon to south of Freeman Canyon. The source of the sulfate is thought to be oxidation of sulfides from the high sulfide calc-silicate hornfels in the Morris Peak-Chimney Peak area, the large pyritic breccia-pipe in upper Sand Canyon, and the skarn of the Tungsten Peak Mine. In this case, the deuterium results are thought to best represent the probable recharge area. The oxygen isotope ratios may be more affected during the oxidation of sulfides than are the hydrogen isotope ratios, although the latter may be affected some by the formation of hydroxyl during the oxidizing processes. Chemical data on the waters of the Tungsten Peak Mine and IWV well 3 are given on pages 30, 31, 36, and 37 of Volume 1 of this technical report; and on pages 10 through 13 of Volume 2. The other well producing sulfate waters is about 3-1/2 miles east-northeast of IWV well 3.

Figure 9 shows possible Sierran recharge areas for the Navy Wells that were sampled for isotope analysis and the well locations. Other data are given in Table 2.

Again the areas of recharge as determined by the isotope ratios of the two elements vary, but do have a large area of overlap. The deuterium data, which give a recharge area from Five Mile Canyon to Indian Wells Canyon, seems reasonable. The oxygen isotope ratios, which give a recharge area from Five Mile Canyon to just south of Little Lake, may show the influence of Red Hill-Brown Road waters mixing with Sierran waters.

The south Ridgecrest waters do not have isotope compositions that give reasonable Sierran recharge areas, perhaps because of recharge from the El Paso Mountains confusing the issue, or because of geothermal and connate fluids flowing from the Sierra (a source south of Walker Pass or upward-dwelling local thermal zones).

* Although Figures 6 through 10 show only the eastern edge of the Sierra, recharge could occur completely across the Sierra, and probably much of the recharge comes from west of the crest where the amount of precipitation is greater.

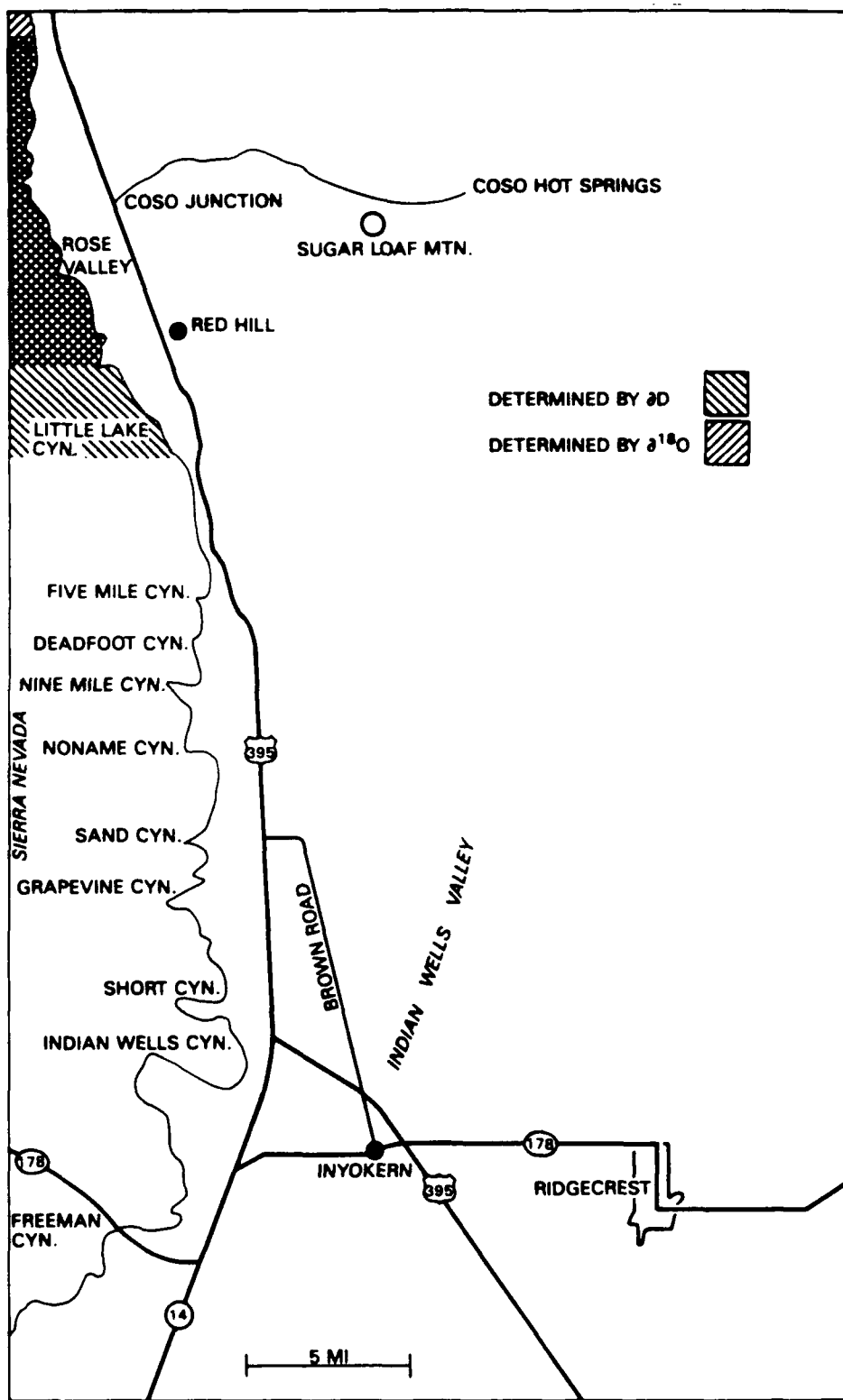


FIGURE 6. Recharge Areas, Rose Valley Groundwaters.

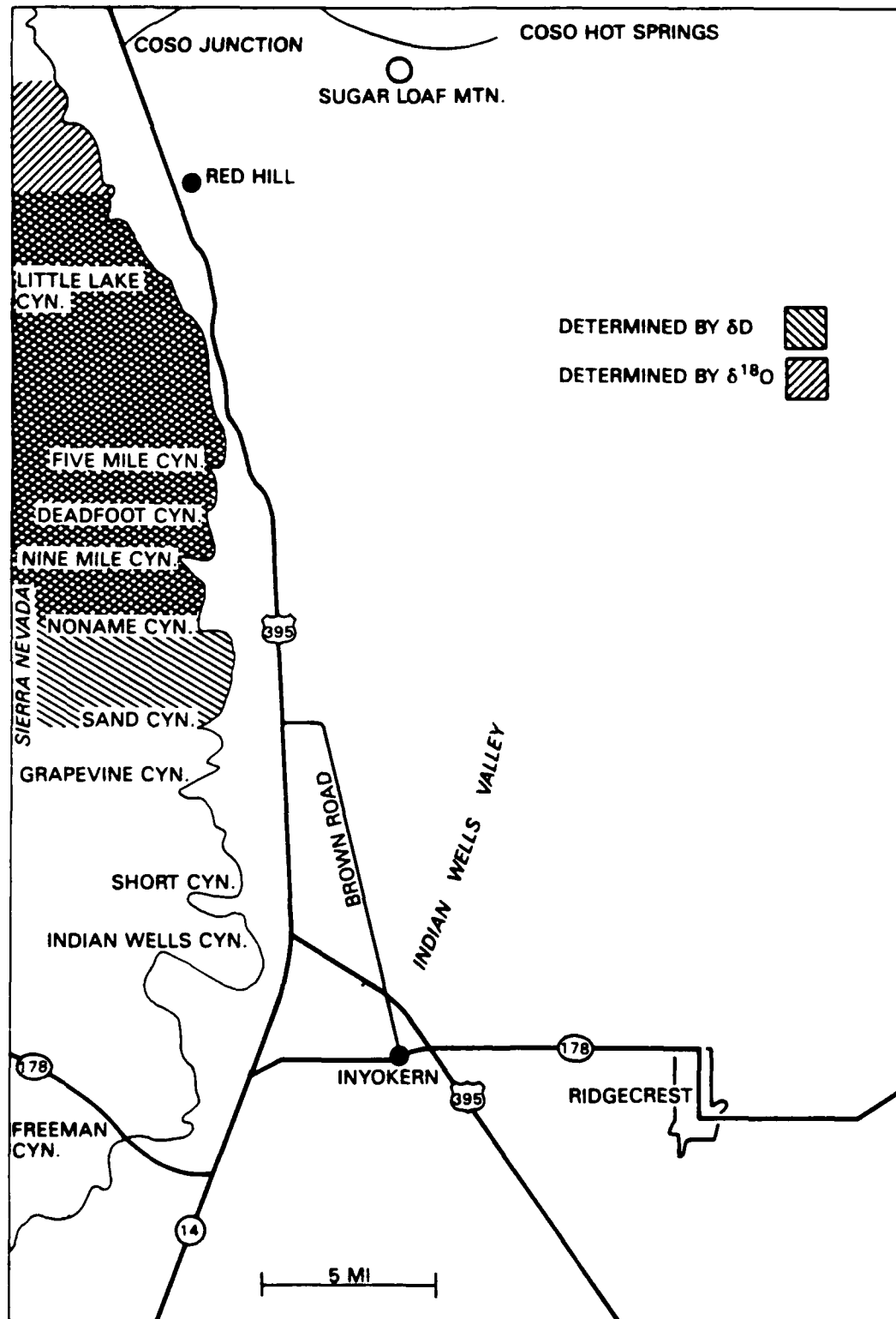


FIGURE 7. Recharge Area, Red Hill to Brown Road Groundwaters.

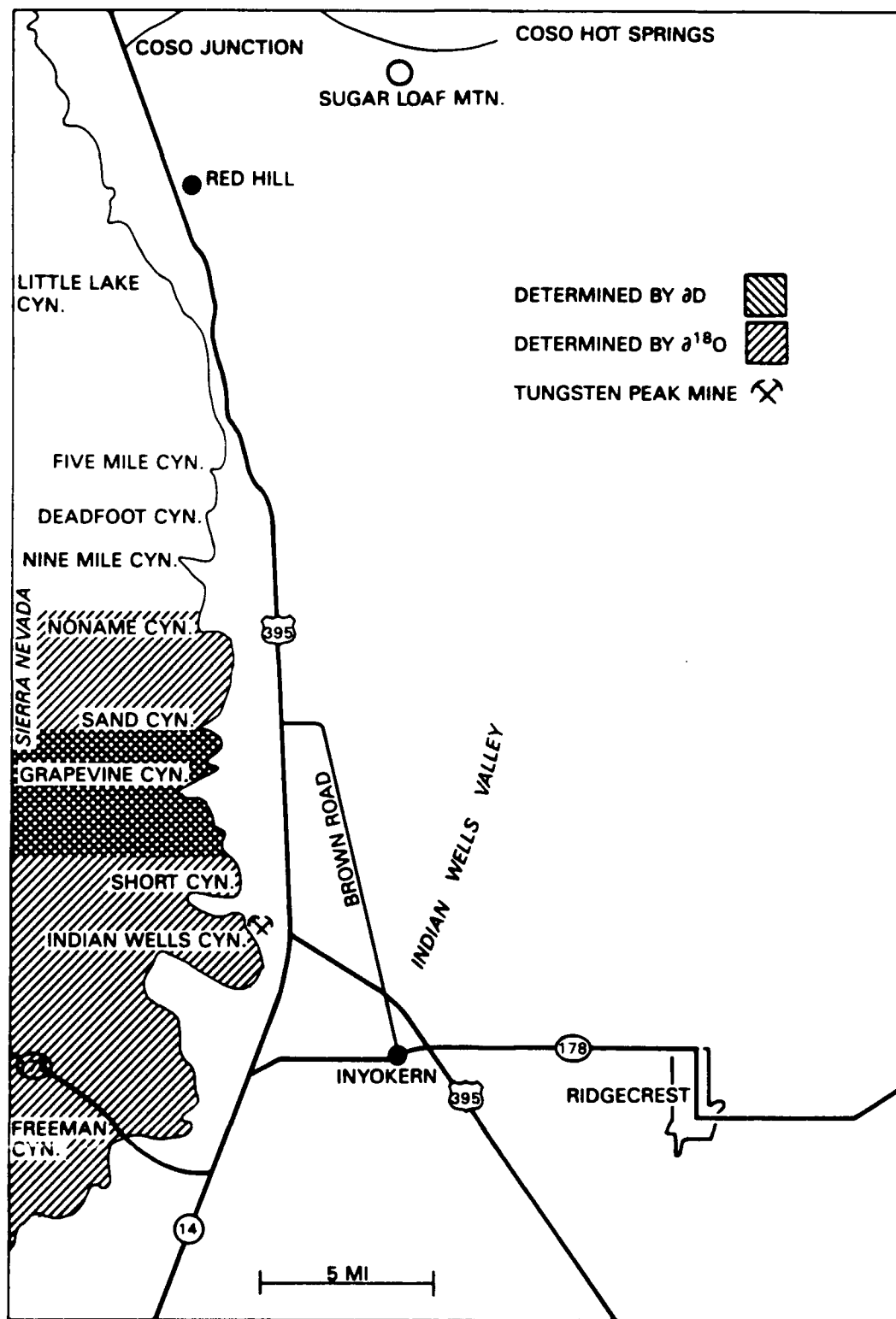


FIGURE 8. Recharge Areas, Sulfate-Bearing Groundwaters.

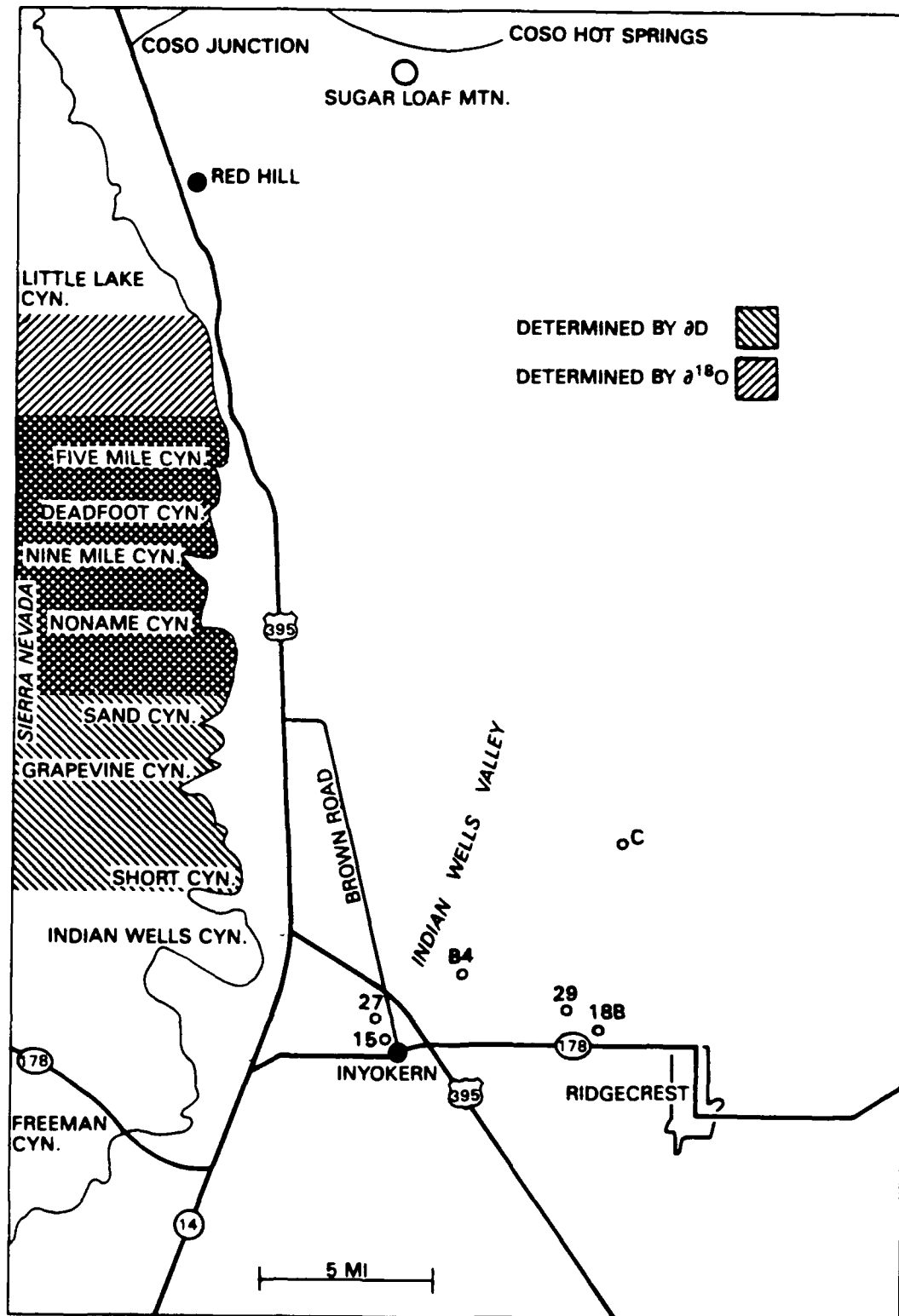


FIGURE 9. Recharge Area, Navy Wells.

TABLE 2. Data on Navy Wells for Which Stable Isotope Analyses of Waters Are Available.

All wells were rotary drilled.				
Well No.	Date drilled	Diameter, in.	Depth, ft	Perforation depth, ft
15	1944	16	446	360-390 405-420
18B	1965	16	800	250-350 490-580 640-780
27	1960	16	803	270-540 550-625 700-791
29	---	16	800	220-405 450-620 730-800
B4 (23)	---	16	800	100-200
C (22)	---	10	200	65-145

Only the deuterium data are applicable to the Coso thermal waters, because thermal waters exhibit a large $\delta^{18}\text{O}$ shift. The deuterium data indicate a possible Sierran recharge area from just south of Coso Junction to Nine Mile Canyon (Figure 10). The Coso geothermal system is bounded by a set of arcuate fractures (Austin and Durbin, 1985, page 37), the western portion of which extends well into the Sierra. This fracture system could indeed be the plumbing for recharge of the geothermal system from the Sierra. The arcuate fracture system is bounded on the south by the Wilson Canyon fault zone. The deuterium data would indicate that if this is so, the southern portion of the arcuate fracture system would be taking more recharge than would the northern. This would be in agreement with the interpretation of convective flow from southwest to northeast as postulated by Moore and others (1989) based on chemical and fluid inclusion data. C. F. Austin has noted that during the drought of the 1960s the South Fork of the Kern River at the latitude of Little Lake disappeared into the bedrock (C. F. Austin, personal communication, 10 April 1989). Flow resumed to the south. This would appear to represent a major infiltration into the westerly extension of the Wilson Canyon fault zone. The Wilson Canyon fault is named for the two Wilson Canyons in the Argus Range. That fault zone, however, goes northwest across Coso Basin, the lavas at the south end of the Coso Range, and into the Sierra where it is the south boundary of the arcuate shear zone (see Austin and Durbin, 1985, pages 54 and 56), and displaces the Sierra Nevada front by 7800 feet.

Buchanan (1989) feels that the concept of modern recharge of geothermal systems by high elevation precipitation may be in error because of the high percolation rates required—meters to tens of meters per day. He proposes a "paleo-fluid recharge" by waters 8000 to 12,000 years old, but this approach ignores the repetitive nature of pluvial/glacial events and is inconsistent with the pluvials of the Coso region as well as being inconsistent with the high hydrologic gradient of 140 feet per mile (Erskine, 1990). Buchanan used the

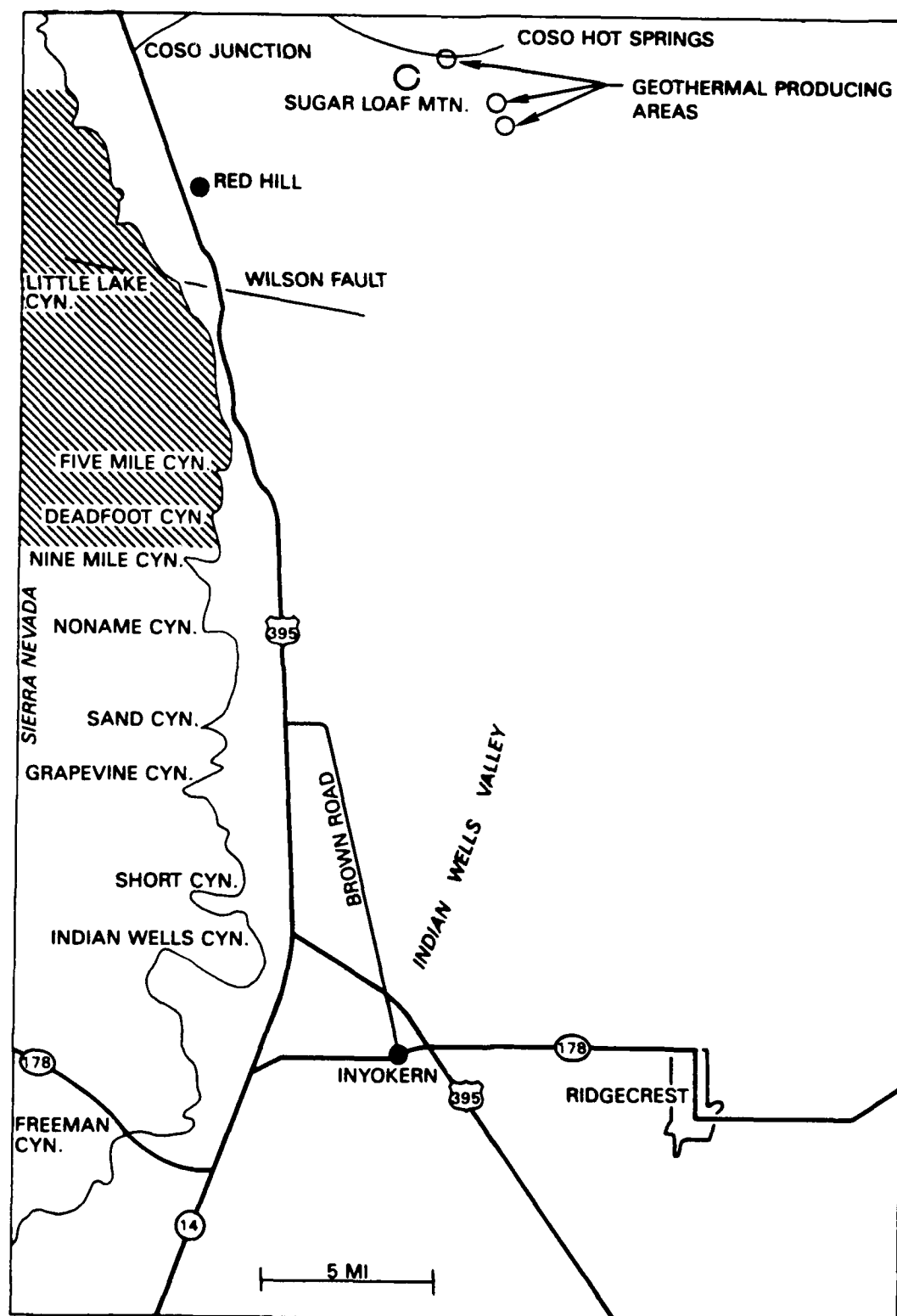


FIGURE 10. Recharge Area for Coso Geothermal Field Based on δD .

paleoclimatic data of Dansgaard and others (1969) who—using isotope data of continuous core from the Greenland ice cap—identified a transition from modern isotopically enriched low-elevation water to paleo-isotopically depleted water between 12,000 and 8000 years before present. However, the climatic shifts possible may not be fully understood or applicable to the Coso, southern Sierra region. Buchanan concludes that nine geothermal systems in Nevada and Utah have paleo-fluid recharge. He attributes the source of the water to be Pleistocene lakes. He assumes that mountain range frontal faults are the plumbing for the water into the geothermal system, based on the models of Gilbert; but the fact that Coso Geothermal Field sits in the midst of a mid-Pliocene orogenic zone and that the positioning of the Sierra may be a very young event (Eardley, 1951), may sharply alter this concept. In the past 10,000 years there have been at least four glacial periods (see Table 1, page 10, Volume 1). The present China Lake playa system has had many predecessors. Lithographic logs of a Navy well drilled near the Inyokern substation indicate at least three shorelines at various depths (see page 10 Volume 1). The Coso geothermal brines should have a complex of pluvial components. Austin and Durbin (1985) in *Coso: Example of a Complex Geothermal Reservoir* in a section entitled Effects of Pluvial Periods, state "As a result of the various pluvial periods of the past, massive flooding of the upper portions of the Coso geothermal system and the attendant periodic flushing out of the shallow chemical components should be the norm." They present convincing evidence that the site of recharge during the pluvial periods would be Rose Valley.

It should be noted, however, that even during pluvial periods, more precipitation will occur at higher elevations. Thus, even if recharge is from valley lakes, most of the water will originate from high-elevation precipitation.

SUMMARY AND CONCLUSIONS

Stable isotopes of hydrogen and oxygen do not at this time appear to uniquely identify the recharge area of the Coso Geothermal Field. Recharge could be from the Sierra or could be locally derived from the high desert ranges; and, in all probability, is a combination of the two. It should be remembered that the high plateaus and valleys of the Coso and Argus Ranges result in a large recharge system of considerable significance even today. There also could be both migrating and static bodies of waters from pluvial periods, which may move quite erratically. The writer feels that the evidence in hand shows the largest component of the recharge waters to be derived from the Sierra southwest of the Coso Geothermal Field for the following reasons: (1) Recharge from the Sierra is concordant with stable hydrogen and oxygen data. (2) Appropriate structures are present to provide the plumbing (the Wilson Canyon fault zone). (3) More precipitation will occur at higher elevations, and the Coso Geothermal Field appears to be a large-volume system.

If one assumes from structural and chemical data that recharge to Rose and Indian Wells Valleys is from the Sierra, one can then use stable isotope data to predict the recharge areas in the Sierra for the various water types.

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Appendix H

**WATER ANALYSES OF NAVY WELLS
(Locations shown on Figure 9)**

This appendix consists of reports of the chemical analysis of water taken from selected wells located at NWC. The water samples were taken and the analyses made intermittently between 31 July 1978 and 6 May 1987. The reports are reproduced here as is to avoid recomposition and proofreading effort and expense.

NWC TP 7019, Supplement

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE 12 Sep 78

NAVWPNSCEN CHINA LAKE

The following is a report of a complete mineral analysis of ^{Water} Well Water

SOURCE OF SAMPLE

Well #15

DATE SAMPLE COLLECTED

31 Jul 78

DATE SAMPLE ANALYZED

31 Jul 78

ANALYST

W. Kester/P. Ma

	ppm	epm		ppm	epm
CALCIUM (Ca)	35.2	1.76	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	6.8	0.56	BICARBONATE (HCO ₃)	92	1.52
SODIUM (Na)	61	2.65	HYDROXIDE (OH)		
POTASSIUM (K)	2.2	0.06	SULPHATE (SO ₄)	86	1.79
			CHLORIDE (Cl)	46	1.29
			NITRATE (NO ₃) N	1.2	0.09
SUM OF EQUIVALENTS		5.03	SUM OF EQUIVALENTS		4.69
	ppm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	116		SILICA (as SiO ₂)		28
CALCIUM HARDNESS (as CaCO ₃)	88		FLUORIDE (F)		0.8
MAGNESIUM HARDNESS (as CaCO ₃)	28		BORON (B)		0.2
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe)	Total	0.043
METHYL ORANGE ALKALINITY (as CaCO ₃)	76		MANGANESE (Mn)	Total	< 0.002
TOTAL DISSOLVED SOLIDS	364		COPPER (Cu)	Total	< 0.001
SPECIFIC CONDUCTIVITY (Micromhos @ 25° C)	520		SYNTHETIC DETERGENTS (APPARENT ABS)		0.016
HYDROGEN ION CONCENTRATION (pH)	7.36		PHOSPHATE (PO ₄)	Total	< 0.02

REMARKS

80727-16 (5)

NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS OF
12ND WEST DIV 11330 16.276

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
13 JULY 1979

TO

Public Works Office, Naval Weapons Station, China Lake

The following is a report of a complete mineral analysis of water Well Water

SOURCE OF SAMPLE

Well 15

DATE SAMPLE COLLECTED

4 May 1979

DATE SAMPLE ANALYZED

May, June 79

ANALYST

Staff

	ppm	epm		ppm	epm
CALCIUM (Ca)	32	1.60	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	9.8	0.80	BICARBONATE (HCO ₃)	98	1.60
SODIUM (Na)	60	2.61	HYDROXIDE (OH)		
POTASSIUM (K)	2.7	0.07	SULPHATE (SO ₄)	110	2.29
			CHLORIDE (Cl)	55	1.55
			NITRATE (NO ₃) N	<1	-
SUM OF EQUIVALENTS		5.08	SUM OF EQUIVALENTS		5.44
		ppm			RESULTS
TOTAL HARDNESS (as CaCO ₃)		120	SILICA (as SiO ₂)		36
CALCIUM HARDNESS (as CaCO ₃)		80	FLUORIDE (F)		0.80
MAGNESIUM HARDNESS (as CaCO ₃)		40	BORON (B)		0.25
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)		0	IRON (Fe) TOTAL		0.274
METHYL ORANGE ALKALINITY (as CaCO ₃)		80	MANGANESE (Mn) TOTAL		0.004
TOTAL DISSOLVED SOLIDS		364	COPPER (Cu) TOTAL		0.022
SPECIFIC CONDUCTIVITY (Micromhos @ 25°C)		520	SYNTHETIC DETERGENTS (APPARENT ABS)		* -
HYDROGEN ION CONCENTRATION (pH)		7.82	PHOSPHATE (PO ₄) TOTAL		0.05

REMARKS

* Insufficient sample to run the test

#90505-12

3

NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS OF WATER
12ND WESTDIV 11330/16 (2-78)

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
24 APRIL 1980

TO

Naval Weapons Center, China Lake

The following is a report of a complete mineral analysis of water:

Well

SOURCE OF SAMPLE

Well #15

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
29 MAR 80	29 MAR 80		staff		
	ppm	epm		ppm	epm
CALCIUM (Ca)	54	2.68	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	4	0.34	BICARBONATE (HCO ₃)	78	1.28
SODIUM (Na)	73	3.17	HYDROXIDE (OH)		
POTASSIUM (K)	2.9	0.07	SULPHATE (SO ₄)	84	1.75
			CHLORIDE (Cl)	116	3.27
			NITRATE (NO ₃ -N)	1.2	0.09
SUM OF EQUIVALENTS		6.12	SUM OF EQUIVALENTS		6.37
	ppm		RESULTS		
TOTAL HARDNESS (as CaCO ₃)	151		SILICA (as SiO ₂) TOTAL	29	
CALCIUM HARDNESS (as CaCO ₃)	134		FLUORIDE (F)	0.84	
MAGNESIUM HARDNESS (as CaCO ₃)	17		BORON (B)	0.36	
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) TOTAL	0.09	
METHYL ORANGE ALKALINITY (as CaCO ₃)	64		MANGANESE (Mn) TOTAL	0.004	
TOTAL DISSOLVED SOLIDS	504		COPPER (Cu) TOTAL	0.06	
SPECIFIC CONDUCTIVITY (Microhm-cm @ 25° C)	720		SYNTHETIC DETERMINANTS (APPARENT ABS)	0.06	
HYDROGEN-ION CONCENTRATION (pH)	7.91		PHOSPHATE (PO ₄) TOTAL	0.02	

REMARKS

700318-16

5

NWC TP 7019, Supplement

Environmental Engineering Laboratory (Southwest Environmental Systems Center 1141), Western Division,
Naval Facilities Engineering Command, 1220 Pacific Highway, San Diego, California 92132

SEP 2 1982

TO

NWC China Lake

The following is a report of a complete in-lab analysis of water: Well Water

SOURCE OF SAMPLE

Well 15

DATE SAMPLE COLLECTED

7/19/82

DATE SAMPLE ANALYZED

7/19 - 8/31/82

ANALYST

Staff

	ppm	epm		ppm	epm
CALCIUM (Ca)	53.6	2.68	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	6.3	.52	BICARBONATE (HCO ₃)	78.1	1.28
SODIUM (Na)	81	3.52	HYDROXIDE (OH ⁻)		
POTASSIUM (K)	2.86	0.07	SULPHATE (SO ₄)	86	1.79
			CHLORIDE (Cl)	120	3.38
			NITRATE (NO ₃)	-N 1.3	0.09
SUM OF EQUIVALENTS	6.79		SUM OF EQUIVALENTS	6.54	
	ppm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	160		SILICA (as SiO ₂)		30
CALCIUM HARDNESS (as CaCO ₃)	134		FLUORIDE (F)		0.89
MAGNESIUM HARDNESS (as CaCO ₃)	26		BORON (B)		0.32
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe)	total	<0.03
METHYL ORANGE ALKALINITY (as CaCO ₃)	64		MANGANESE (Mn)	total	<0.01
TOTAL DISSOLVED SOLIDS Gravimetric	441		COPPER (Cu)	total	<0.01
SPECIFIC CONDUCTIVITY (V/cm, 25°C)	780		SYNTHETIC DETERGENTS (APPARENT ABS)		0.059
HYDROGEN ION CONCENTRATION (pH)	7.74		PHOSPHATE (PO ₄)	total	<0.05
Temperature °F	82-84		Langlier Index		-0.15
pHs	7.89		Ryzner Index		8.04

REMARKS

20716-14

2

NWC TP 7019, Supplement



MAIN OFFICE: 4100 PIERCE ROAD, BAKERSFIELD, CA. 93308 PHONE 327-4911

Submitted by: Naval Weapons Center
China Lake, California 93555

Date Reported: 12/27/85
Date Received: 11/20/85
Laboratory No.: 20403

Sample Description: Harvey Field
Sample 15, 11/19/85, sample collected by: David Rittenhouse of B C Labs

WATER ANALYSIS

CONSTITUENTS	mg/liter	DESIRABLE LIMITATIONS
Calcium (Ca)	34.	
Magnesium (Mg)	4.7	125.
Sodium (Na)	63.	350.
Potassium (K)	2.5	-
Carbonate (CO ₃)	0.	25.
Bicarbonate (HCO ₃)	118.	250.
Chloride (Cl)	37.2	250 - 500 (600 short term)
Sulfate (SO ₄)	90.	250 - 500 (600 short term)
Nitrate (NO ₃)	6.6	45.
Fluoride (F)	0.68	1.0
Iron (Fe)	(-) 0.05	0.3
Manganese (Mn)	(-) 0.01	0.05
Arsenic (As)	(-) 0.01	0.05
Copper (Cu)	(-) 0.01	1.0
Zinc (Zn)	0.02	5.0
MBAS	(-) 0.10	0.5
Hardness as CaCO ₃	105. (6.1 gr/gal)	200 ppm medium hard, 50-100 ppm very soft
Total Solids	335.	500 - 1000 (1500 short term)
pH	7.7	
Electrical Conductivity	510.	
Micromhos/cm (K x 10 ⁶) @ 25°C		900 - 1600 (2200 short term)
Color	.	15
Odor	no observed odor	3.0
Turbidity	0.23	5.0 NT Units
Barium (Ba)	(-) 0.5	1.0
Cadmium (Cd)	(-) 0.005	0.010
Chromium (Cr)	(-) 0.01	0.05
Lead (Pb)	(-) 0.01	0.05
Mercury (Hg)	(-) 0.0002	0.002
Selenium (Se)	(-) 0.005	0.01
Silver (Ag)	(-) 0.01	0.05

- refer to "Notes" page.

ENC. 1.

By J. J. Eglin
J. J. Eglin

NWC TP 7019, Supplement

MINERAL ANALYSIS OF WATER
 FORM 11220-18 (2-76)

Environmental Engineering Laboratory, Western Division,
 Naval Facilities Engineering Command, San Diego, California 92132

13 JULY 1979

Public Works Office, Naval Weapons Station, China Lake

Following is a report of a complete mineral analysis of water Well Water

NAME OF SAMPLE

11 18B

SAMPLE COLLECTED

May 1979

DATE SAMPLE ANALYZED

May, June 79

ANALYST

Staff

	ppm	epm		ppm	epm
LIUM (Ca)	13	0.64	CARBONATE (CO ₃)	12	0.40
MAGNESIUM (Mg)	3.9	0.32	BICARBONATE (HCO ₃)	68	1.12
SODIUM (Na)	56	2.43	HYDROXIDE (OH)		
POTASSIUM (K)	1.9	0.05	SULPHATE (SO ₄)	24	0.50
			CHLORIDE (Cl)	29	0.82
			NITRATE (NO ₃)	<1	-
SUM OF EQUIVALENTS	3.44		SUM OF EQUIVALENTS	2.84	
	ppm			RESULTS	
HARDNESS (as CaCO ₃)	48		SILICA (as SiO ₂)	27	
MIN HARDNESS (as CaCO ₃)	32		FLUORIDE (F)	0.86	
MINIMUM HARDNESS (as CaCO ₃)	16		BORON (B)	0.36	
PHENOL ALKALINITY (as CaCO ₃)	20		IRON (Fe) TOTAL	0.049	
ORANGE ALKALINITY (as CaCO ₃)	96		MANGANESE (Mn) TOTAL	< 0.002	
DISSOLVED SOLIDS	259		COPPER (Cu) TOTAL	0.022	
ELECTRIC CONDUCTIVITY (Micro-mhos @ 25° C)	370		SYNTHETIC DETERGENTS (APPARENT ABS)	0.09	
GEN-ION CONCENTRATION (pH)	9.01		PHOSPHATE (PO ₄) TOTAL	0.05	

505-12

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NWC TP 7019, Supplement

WEST DIV 11330/10 (2-78)

Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE

24 APRIL 1980

Naval Weapons Center, China Lake

Following is a report of a complete mineral analysis of water: Well

OF SAMPLE

1 #188

SAMPLE COLLECTED

DATE SAMPLE ANALYZED

ANALYST

MAR 80

29 MAR 80

staff

	ppm	spn		ppm	spn
Ca (Ca)	2	0.08	CARBONATE (CO ₃)	43.2	1.44
SiUM (Mg)	0.5	0.04	BICARBONATE (HCO ₃)	58.6	0.96
(Na)	83	3.61	HYDROXIDE (OH)		
UM (K)	0.54	0.01	SULPHATE (SO ₄)	13	0.27
			CHLORIDE (Cl)	68	1.92
			NITRATE (NO ₃)	<1	-
SUM OF EQUIVALENTS		3.74	SUM OF EQUIVALENTS		4.59
	ppm			RESULTS	
HARDNESS (as CaCO ₃)	6.3		SILICA (as SiO ₂)	TOTAL	26
HARDNESS (as CaCO ₃)	4.2		FLUORIDE (F)		0.84
HM HARDNESS (as CaCO ₃)	2.1		BORON (B)		0.54
THALIN ALKALINITY (as CaCO ₃)	36		IRON (Fe)	TOTAL	0.02
RANGE ALKALINITY (as CaCO ₃)	120		MANGANESE (Mn)	TOTAL	0.001
SOLVED SOLIDS	308		COPPER (Cu)	TOTAL	<0.01
INDUCTIVITY (Micromhos @ 25° C)	440		SYNTHETIC DETERGENTS (as TARENT ABS)		0.05
ION CONCENTRATION (pH)	9.20		PHOSPHATE (PO ₄)	TOTAL	0.09

8-16

6

NWC TP 7019, Supplement



MAIN OFFICE: 4100 PIERCE ROAD, BAKERSFIELD, CA 93308 PHONE 327-4911

Submitted by: Naval Weapons Center
China Lake, California 93555

Date Reported: 12/27/85
Date Received: 11/20/85
Laboratory No.: 20404

Sample Description: ^{Intermediate} Sample 18B 11/19/85 sample collected by: David Rittenhouse of B C Labs

WATER ANALYSIS

CONSTITUENTS	mg/liter	DESIRABLE LIMITATIONS
Calcium (Ca)	12.	
Magnesium (Mg)	2.4	125.
Sodium (Na)	59.	350.
Potassium (K)	2.5	-
Carbonate (CO ₃)	9.4	25.
Bicarbonate (HCO ₃)	120.	250.
Chloride (Cl)	19.8	250 - 500 (600 short term)
Sulfate (SO ₄)	27.	250 - 500 (600 short term)
Nitrate (NO ₃)	6.2	45.
Fluoride (F)	0.75	1.0
Iron (Fe)	(-) 0.05	0.3
Manganese (Mn)	(-) 0.01	0.05
Arsenic (As)	0.01	0.05
Copper (Cu)	(-) 0.01	1.0
Zinc (Zn)	(-) 0.01	5.0
MBAS	(-) 0.1	0.5
Hardness as CaCO ₃	39.9 (2.3gr/gal)	200 ppm medium hard, 50-100 ppm very soft
Total Solids	215.	500 - 1000 (1500 short term)
pH	8.3	
Electrical Conductivity	340.	
Micromhos/cm (K x 10 ⁶) @ 25°C		900 - 1600 (2200 short term)
Color	1.	15
Odor	no observed odor	3.0
Turbidity	0.24	5.0 NT Units
Barium (Ba)	(-) 0.5	1.0
Cadmium (Cd)	(-) 0.005	0.010
Chromium (Cr)	(-) 0.01	0.05
Lead (Pb)	(-) 0.01	0.05
Mercury (Hg)	(-) 0.0002	0.002
Selenium (Se)	(-) 0.005	0.01
Silver (Ag)	(-) 0.01	0.05

(-) refers to "less than".

By J. J. Eglin
J. J. Eglin

NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS
12ND WESTDIV 11330 18 (2 76)

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE 13 JULY 1979

TO

Public Works Office, Naval Weapons Station, China Lake

The following is a report of a complete mineral analysis of water Well Water

SOURCE OF SAMPLE

Well 22

DATE SAMPLE COLLECTED

4 May 1979

DATE SAMPLE ANALYZED

May, June 1979

ANALYST

Staff

	ppm	epm		ppm	epm
CALCIUM (Ca)	38	1.92	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	26	2.16	BICARBONATE (HCO ₃)	312	5.12
SODIUM (Na)	160	6.95	HYDROXIDE (OH)		
POTASSIUM (K)	13.2	0.34	SULPHATE (SO ₄)	138	2.88
			CHLORIDE (Cl)	109	3.07
			NITRATE (NO ₃ -N)	<1	
SUM OF EQUIVALENTS		11.37	SUM OF EQUIVALENTS		11.07
	ppm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	204		SILICA (as SiO ₂)	42	
CALCIUM HARDNESS (as CaCO ₃)	96		FLUORIDE (F)	1.0	
MAGNESIUM HARDNESS (as CaCO ₃)	108		BORON (B)	2.7	
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) TOTAL	0.016	
METHYL ORANGE ALKALINITY (as CaCO ₃)	256		MANGANESE (Mn) TOTAL	0.002	
TOTAL DISSOLVED SOLIDS	728		COPPER (Cu) TOTAL	0.016	
SPECIFIC CONDUCTIVITY (Microhm/cm @ 25° C)	1040		SYNTHETIC DETERGENTS (APPARENT ABS)	0.04	
HYDROGEN-ION CONCENTRATION (pH)	7.81		PHOSPHATE (PO ₄) TOTAL	0.05	

REMARKS

#90505-12

10

H-10

NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS OF WATER
12ND WESTDIV (1330/18 (2-78))

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
24 APRIL 1980

TO
Naval Weapons Center, China Lake

The following is a report of a complete mineral analysis of water Well

SOURCE OF SAMPLE

Well #22

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
29 MAR 80	29 MAR 80		staff		
	ppm	epm		ppm	epm
CALCIUM (Ca)	44	2.18	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	23	1.86	BICARBONATE (HCO ₃)	317	5.20
SODIUM (Na)	182	7.91	HYDROXIDE (OH)		
POTASSIUM (K)	19.1	0.36	SULPHATE (SO ₄)	139	2.90
			CHLORIDE (Cl)	148	4.17
			NITRATE (NO ₃) N	41	-
SUM OF EQUIVALENTS		12.31	SUM OF EQUIVALENTS		12.27
	ppm		RESULTS		
TOTAL HARDNESS (as CaCO ₃)	202		SILICA (as SiO ₂) TOTAL		45
CALCIUM HARDNESS (as CaCO ₃)	109		FLUORIDE (F)		0.9
MAGNESIUM HARDNESS (as CaCO ₃)	93		BORON (B)		2.1
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) TOTAL		0.12
METHYL ORANGE ALKALINITY (as CaCO ₃)	260		MANGANESE (Mn) TOTAL		0.009
TOTAL DISSOLVED SOLIDS	840		COPPER (Cu) TOTAL		0.03
SPECIFIC CONDUCTIVITY (Micromhos @ 25° C)	1200		SYNTHETIC DETERGENTS (APPARENT ABS)		0.06
HYDROGEN-ION CONCENTRATION (pH)	7.89		PHOSPHATE (PO ₄) TOTAL		0.10

REMARKS

#00318-16

9

H-11

NWC TP 7019, Supplement

FROM Environmental Engineering Laboratory, Southwest Environmental Section (Code 1141), Western Division, Naval Facilities Engineering Command, 1220 Pacific Highway, San Diego, California 92132	DATE 2 SEPT 1982
TO Naval Weapons Center, China Lake	

The following is a report of a complete mineral analysis of water: **Well Water**

SOURCE OF SAMPLE

Well #22 (C - Range)

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
19 JUL 1982	19 JUL - 31 AUG 1982		STAFF		
	ppm	ppm		ppm	ppm
CALCIUM (Ca)	38.8	1.94	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	28.5	2.34	BICARBONATE (HCO ₃)	336.7	5.52
SODIUM (Na)	172	7.48	HYDROXIDE (OH)		
POTASSIUM (K)	13.5	0.35	SULPHATE (SO ₄)	132	2.75
			CHLORIDE (Cl)	128	3.61
			NITRATE (XXX) -N	0.5	-----
SUM OF EQUIVALENTS		12.10	SUM OF EQUIVALENTS		11.88
	ppm		RESULTS		
TOTAL HARDNESS (as CaCO ₃)	214		SILICA (as SiO ₂)	39	
CALCIUM HARDNESS (as CaCO ₃)	97		FLUORIDE (F)	0.95	
MAGNESIUM HARDNESS (as CaCO ₃)	117		BORON (B)	2.8	
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe)	Total	0.03
METHYL ORANGE ALKALINITY (as CaCO ₃)	276		MANGANESE (Mn)	Total	0.01
TOTAL DISSOLVED SOLIDS Gravimetric	729		COPPER (Cu)	Total	0.04
SPECIFIC CONDUCTIVITY (Microhm/cm @ 25° C)	1250		SYNTHETIC DETERGENTS (APPARENT ABS)	0.041	
HYDROGEN-ION CONCENTRATION (pH)	7.76		PHOSPHATE (PO ₄)	Total	0.05
Temperature °F	76		Langlier Index	+0.36	
PHS	7.40		Ryzner Index	7.04	

20716-14

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H-12

TITLE 22 CHEMICAL ANALYSES

Date of Report		Lab Sample ID Number 88136	
Laboratory Name FGL		Signature Lab Director [Signature]	
Name of Sampler Knut J Beruldsen		Sampler Employed By Naval Weapons Center	
Date/Time Sample Collected April 28, 1987 0900hrs	Date/Time Sample Received at Lab.	Were Holding Times Observed?	
System Name U.S. Naval Weapons Center		System Number 15-703	
Description of Sampling Point hose attached to pump discharge line			
Name/Number of Sample Source Area C Tower / Well # 22		Station Number	
Date and Time of Sample 8 7 0 4 2 8 0 9 0 0	Water Type G/S	User ID	Submitted to SWQIS By
Y V M M O D T T T T			

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
	Analyzing Agency (Laboratory)		28	
mg/L	Total Hardness (as CaCO ₃)		900	2 0 5
mg/L	Calcium (Ca)		916	4 0
mg/L	Magnesium (Mg)		927	2 5
mg/L	Sodium (Na)		929	1 7 7
mg/L	Potassium (K)		937	2 0
Total Cations meq/L Value:				

mg/L	Total Alkalinity (as CaCO ₃)		410	3 0 5
mg/L	Hydroxide (OH)		71830	0
mg/L	Carbonate (CO ₃)		445	0
mg/L	Bicarbonate (HCO ₃)		440	3 7 2
mg/L +	Sulfate (SO ₄)		945	1 2 9
mg/L +	Chloride (Cl)		940	1 1 7
45 mg/L	Nitrate (NO ₃)		71850	1
1.4-2.4 mg/L	Fluoride (F) Temp. Depend.		951	0 0 8
Total Anions meq/L Value:				

Std Units	pH (Laboratory)		403	7 0 8
** umho/cm +	Specific Conductance (E.C.)		95	1 2 4 0
*** mg/L +	Total Filterable Residue at 180° C (TDS)		70300	6 9 2
UNITS	Apparent Color (Unfiltered)		81	< 5
TON	Odor Threshold at 60° C		86	< 1
NTU	Lab Turbidity		82079	2 0 0
0.5 mg/L +	MBAS		38260	< 0 0 5

• 250-500-600

** 900-1600-2200

*** 500-1000-1500

MS 8351 (11/86)

Enclosure (1)

U.S. Naval Weapon Center, well 22 88136

• THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L •

Constituent	T T	Storet Code	Analyses Results
Arsenic (As)		1002	< 3.0
Barium (Ba)		1007	< 5.0
Cadmium (Cd)		1027	< 5.0
Chromium (Total Cr)		1034	< 3.0
Copper (Cu)		1042	< 1.0
Iron (Fe)		1045	< 6.0
Lead (Pb)		1051	< 3.0
Manganese (Mn)		1055	< 3.0
Mercury (Hg)		71900	< 1.0
Selenium (Se)		1147	< 5.0
Silver (Ag)		1077	< 3.0
Zinc (Zn)		1092	< 1.0

ORGANIC CHEMICALS

Endrin		39390							
Lindane		39340							
Methoxychlor		39480							
Toxaphene		39400							
2,4-D		39730							
2,4,5-TP Silvex		39045							
ORGANIC Analyses Completed		73672							
			Y	Y	M	M	D	D	

ADDITIONAL ANALYSES

Field Turbidity		82078							
Source Temperature		10							
Langelier Index Source Temp.		71814							
Langelier Index at 60° C		71813							
Field pH		00400							
Aggressiveness Index		82383							
Silica		00955							
Phosphate		00650							
Iodide		71865							
Sodium Absorption Ratio		00931							
Asbestos		8155							
<i>gross alpha</i>									<i>1.1 ± 4.3</i>

See Secondary Drinking Water Standards

NWC TP 7019, Supplement

Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

12 Sep 78

NAVWENSCEN CHINA LAKE

The following is a report of a complete mineral analysis of water **Well Water**

SOURCE OF SAMPLE

Well #23

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
31 Jul 78	31 Jul 78		W. Kester/P. Ma		
	pdm	epm		pdm	epm
CALCIUM (Ca)	57.6	2.88	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	14.6	1.20	BICARBONATE (HCO ₃)	181	2.96
SODIUM (Na)	109	4.73	HYDROXIDE (OH)		
POTASSIUM (K)	3.3	0.08	SULPHATE (SO ₄)	180	3.75
			CHLORIDE (Cl)	71	2.00
			NITRATE (NO ₃)	0.32	0.02
SUM OF EQUIVALENTS		8.89	SUM OF EQUIVALENTS		8.73
	pdm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	204		SILICA (as SiO ₂)		28
CALCIUM HARDNESS (as CaCO ₃)	144		FLUORIDE (F)		0.88
MAGNESIUM HARDNESS (as CaCO ₃)	60		BORON (B)		0.2
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe)	Total	0.438
METHYL ORANGE ALKALINITY (as CaCO ₃)	148		MANGANESE (Mn)	Total	0.053
TOTAL DISSOLVED SOLIDS	630		COPPER (Cu)	Total	0.006
SPECIFIC CONDUCTIVITY (Micromhos @ 25°C)	900		SYNTHETIC DETERGENTS (APPARENT ABS)		0.022
HYDROGEN ION CONCENTRATION (pH)	7.44		PHOSPHATE (PO ₄)	Total	0.17

REMARKS

* Recorded result of Sulfate (SO₄) based on the previous results; insufficient sample for further test.

80727-16 (11)

NWC TP 7019, Supplement

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Naval Weapons Center, China Lake

The following is a report of a complete mineral analysis of water Well Water

SOURCE OF SAMPLE

Well #23 (B-4 Range)

DATE SAMPLE COLLECTED

19 JUL 1982

DATE SAMPLE ANALYZED

19 JUL - 31 AUG 1982

ANALYST

STAFF

	ppm	epm		ppm	epm
CALCIUM (Ca)	58.8	2.94	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	13.4	1.10	BICARBONATE (HCO ₃)	175.7	2.89
SODIUM (Na)	114	4.96	HYDROXIDE (OH)		
POTASSIUM (K)	3.50	0.09	SULPHATE (SO ₄)	174	3.62
			CHLORIDE (Cl)	108	3.04
			NITRATE (NO ₃) -N	0.5	
SUM OF EQUIVALENTS	9.09		SUM OF EQUIVALENTS	9.54	
	ppm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	202		SILICA (as SiO ₂)	39	
CALCIUM HARDNESS (as CaCO ₃)	147		FLUORIDE (F)	0.89	
MAGNESIUM HARDNESS (as CaCO ₃)	55		BORON (B)	0.71	
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) Total	0.15	
METHYL ORANGE ALKALINITY (as CaCO ₃)	144		MANGANESE (Mn) Total	0.06	
TOTAL DISSOLVED SOLIDS Gravimetric	573		COPPER (Cu) Total	<0.01	
SPECIFIC CONDUCTIVITY (Microhm/cm @ 25°C)	950		SYNTHETIC DETERGENTS (APPARENT ABS)	0.041	
HYDROGEN ION CONCENTRATION (pH)	7.44		PHOSPHATE (PO ₄) Total	0.05	
Temperture °F	76		Langlier Index	-0.07	
PHS	7.47		Ryzner Index	7.50	

REMARKS

20716-14

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NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS OF WATER 12ND WESTDIV 11330/18 (2-78)

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
24 APRIL 1980

TO

Naval Weapons Center, China Lake

The following is a report of a complete mineral analysis of water

Well

SOURCE OF SAMPLE

Well #23

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
29 MAR 80	29 MAR 80		staff		
	ppm	spm		ppm	spm
CALCIUM (Ca)	60	3.02	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	11	0.92	BICARBONATE (HCO ₃)	171	2.80
SODIUM (Na)	120	5.22	HYDROXIDE (OH)		
POTASSIUM (K)	3.7	0.09	SULPHATE (SO ₄)	203	4.23
			CHLORIDE (Cl)	76	2.14
			NITRATE (NO ₃) N	<1	-
SUM OF EQUIVALENTS		9.25	SUM OF EQUIVALENTS		9.17
	ppm		RESULTS		
TOTAL HARDNESS (as CaCO ₃)	197		SILICA (as SiO ₂) TOTAL		35
CALCIUM HARDNESS (as CaCO ₃)	151		FLUORIDE (F)		0.82
MAGNESIUM HARDNESS (as CaCO ₃)	46		BORON (B)		0.71
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) TOTAL		2.30
METHYL ORANGE ALKALINITY (as CaCO ₃)	140		MANGANESE (Mn) TOTAL		0.088
TOTAL DISSOLVED SOLIDS	665		COPPER (Cu) TOTAL		< 0.01
SPECIFIC CONDUCTIVITY (Microhm/cm @ 25° C)	950		SYNTHETIC DETERGENTS (APPARENTLY)		0.06
HYDROGEN-ION CONCENTRATION (pH)	7.87		PHOSPHATE (PO ₄) TOTAL		0.05

REMARKS

#00318-16

10

H-17

NWC TP 7019, Supplement

TITLE 22 CHEMICAL ANALYSES

Date of Report 5-13-87		Lab Sample ID Number 88901	
Laboratory Name FGL		Signature Lab Director <i>May Wamp</i>	
Name of Sampler Knut J. Beruldsen		Sampler Employed By Naval Weapons Center	
Date/Time Sample Collected 5/16/87 0900 hrs	Date/Time Sample Received at Lab.	Were Holding Times Observed?	
System Name 11.5 Naval Weapons Center		System Number 15-703	
Description of Sampling Point base bibb			
Name/Number of Sample Source B4 Range / Well # 23		Station Number	
Date and Time of Sample 8 7 10 15 10 16 0 9 10 10 Y Y M M D D T T T T	Water Type G/S	User ID	Submitted to SWQIS By

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
	Analyzing Agency (Laboratory)		28	
mg/L	Total Hardness (as CaCO ₃)		900	4.5
mg/L	Calcium (Ca)		916	1.3
mg/L	Magnesium (Mg)		927	1.3
mg/L	Sodium (Na)		929	1.3
mg/L	Potassium (K)		937	1.3
Total Cations meq/L Value:				

mg/L	Total Alkalinity (as CaCO ₃)		410	7.0
mg/L	Hydroxide (OH)		71830	0
mg/L	Carbonate (CO ₃)		445	0
mg/L	Bicarbonate (HCO ₃)		440	8.5
mg/L +	Sulfate (SO ₄)		945	3
mg/L +	Chloride (Cl)		940	16
45 mg/L	Nitrate (NO ₃)		71850	< 1.0
1.4-2.4 mg/L	Fluoride (F) Temp. Depend.		951	0.1
Total Anions meq/L Value:				

Std Units	pH (Laboratory)		403	7.0
** umho/cm +	Specific Conductance (E.C.)		95	17.0
*** mg/L +	Total Filterable Residue at 180° C (TDS)		70300	10.0
UNITS	Apparent Color (Unfiltered)		81	< 5
TON	Odor Threshold at 60° C		86	< 1
NTU	Lab Turbidity		82079	6.2
0.5 mg/L +	MBAS		38260	< 0.05

• 250-500-600

** 900-1600-2200

*** 500-1000-1500

DHS 8351 (11/86)

Enclosure (3)

more data on outside

• THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L •

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
50 ug/L	Arsenic (As)		1002	< 3.0
1000 ug/L	Barium (Ba)		1007	< 5.0
10 ug/L	Cadmium (Cd)		1027	< 5.0
50 ug/L	Chromium (Total Cr)		1034	< 3.0
1000 ug/L+	Copper (Cu)		1042	< 1.0
300 ug/L+	Iron (Fe)		1045	< 1.0
50 ug/L	Lead (Pb)		1051	< 3.0
50 ug/L+	Manganese (Mn)		1055	< 3.0
2 ug/L	Mercury (Hg)		71900	< 1.0
10 ug/L	Selenium (Se)		1147	< 5.0
50 ug/L	Silver (Ag)		1077	< 3.0
5000 ug/L	Zinc (Zn)		1092	< 8.0

ORGANIC CHEMICALS

0.2	ug/L	Endrin	39390					
4	ug/L	Lindane	39340					
100	ug/L	Methoxychlor	39480					
5	ug/L	Toxaphene	39400					
100	ug/L	2, 4-D	39730					
10	ug/L	2, 4, 5-TP Silvex	39045					
Date OFGANC Analyses Completed			73672					

ADDITIONAL ANALYSES

[illegible]

+ indicates Secondary Drinking Water Standards

NWC TP 7019, Supplement

FORM 100-100-100-100-100

FROM: Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE: 12 Sep 78

NAVTPNSCEN CHINA LAKE

The following is a report of a complete mineral analysis of water

Well Water

SOURCE OF SAMPLE

Well #27

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
31 Jul 78	31 Jul 78		W. Kester/ P. Ma		
	ppm	epm		ppm	epm
CALCIUM (Ca)	68.8	3.44	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	8.8	6.72	BICARBONATE (HCO ₃)	58.6	0.96
SODIUM (Na)	56	2.43	HYDROXIDE (OH)		
POTASSIUM (K)	3.3	0.08	SULPHATE (SO ₄)	79	1.65
			CHLORIDE (Cl)	143	4.02
			NITRATE (NO ₃)	0.85	0.06
SUM OF EQUIVALENTS		6.67	SUM OF EQUIVALENTS		6.69
		ppm			RESULTS
TOTAL HARDNESS (as CaCO ₃)		208	SILICA (as SiO ₂)		20
CALCIUM HARDNESS (as CaCO ₃)		172	FLUORIDE (F)		0.68
MAGNESIUM HARDNESS (as CaCO ₃)		36	BORON (B)		0.14
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)		0	IRON (Fe)	Total	0.219
METHYL ORANGE ALKALINITY (as CaCO ₃)		48	MANGANESE (Mn)	Total	< 0.002
TOTAL DISSOLVED SOLIDS		560	COPPER (Cu)	Total	0.002
SPECIFIC CONDUCTIVITY (Micro-mhos @ 25° C)		800	SYNTHETIC DETERGENTS (APPARENT ABS)		0.008
HYDROGEN ION CONCENTRATION (pH)		7.47	PHOSPHATE (PO ₄)	Total	< 0.02

REMARKS

80227-16 (13)

NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS
12ND WES DIV 11330 1B (2 76)

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
13 JULY 1979

TO
Public Works Office, Naval Weapons Station, China Lake

The following is a report of a complete mineral analysis of water Well Water

SOURCE OF SAMPLE

Well 27

DATE SAMPLE COLLECTED

4 May 1979

DATE SAMPLE ANALYZED

May, June 1979

ANALYST

Staff

	ppm	epm		ppm	epm
CALCIUM (Ca)	59	2.96	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	12	0.96	BICARBONATE (HCO ₃)	63	1.04
SODIUM (Na)	65	2.83	HYDROXIDE (OH)		
POTASSIUM (K)	2.5	0.06	SULPHATE (SO ₄)	84	1.75
			CHLORIDE (Cl)	142	3.44
			NITRATE (NO ₃)	<1	-
SUM OF EQUIVALENTS		6.71	SUM OF EQUIVALENTS		6.23
	ppm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	196		SILICA (as SiO ₂)	32	
CALCIUM HARDNESS (as CaCO ₃)	148		FLUORIDE (F)	0.72	
MAGNESIUM HARDNESS (as CaCO ₃)	48		BORON (B)	0.36	
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) TOTAL	0.553	
METHYL ORANGE ALKALINITY (as CaCO ₃)	52		MANGANESE (Mn) TOTAL	0.003	
TOTAL DISSOLVED SOLIDS	490		COPPER (Cu) TOTAL	0.011	
SPECIFIC CONDUCTIVITY (Micromhos @ 25° C)	700		SYNTHETIC DETERGENTS (APPARENT ABS)	* -	
HYDROGEN ION CONCENTRATION (pH)	7.75		PHOSPHATE (PO ₄) TOTAL	<0.03	

REMARKS

* Insufficient sample to run the test

90505-12

2.

NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS OF WATER 12ND WEST DIV 11330/18 (2-78)

FROM Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
24 APRIL 1980

TO

Naval Weapons Center, China Lake

The following is a report of a complete mineral analysis of water Well

SOURCE OF SAMPLE

Well #27

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
29 MAR 80	29 MAR 80		staff		
	ppm	ppm		ppm	ppm
CALCIUM (Ca)	63	3.15	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	7	0.60	BICARBONATE (HCO ₃)	73	1.20
SODIUM (Na)	64	2.78	HYDROXIDE (OH)		
POTASSIUM (K)	2.8	0.07	SULPHATE (SO ₄)	81	1.69
			CHLORIDE (Cl)	128	3.61
			NITRATE (NO ₃) N	41	-
SUM OF EQUIVALENTS		6.60	SUM OF EQUIVALENTS		6.50
		ppm		RESULTS	
TOTAL HARDNESS (as CaCO ₃)		185	SILICA (as SiO ₂) TOTAL		32
CALCIUM HARDNESS (as CaCO ₃)		155	FLUORIDE (F)		0.60
MAGNESIUM HARDNESS (as CaCO ₃)		30	BORON (B)		0.32
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)		0	IRON (Fe) TOTAL		0.05
METHYL ORANGE ALKALINITY (as CaCO ₃)		60	MANGANESE (Mn) TOTAL		40.001
TOTAL DISSOLVED SOLIDS		518	COPPER (Cu) TOTAL		40.01
SPECIFIC CONDUCTIVITY (Microhm-cm @ 25° C)		740	SYNTHETIC DETERGENTS (APPARENT TAP)		0.03
HYDROGEN-ION CONCENTRATION (pH)		8.07	PHOSPHATE (PO ₄) TOTAL		0.047

FORM 800-1

#00318-16

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INDUSTRIAL/EDUCATION/RESEARCH

Environmental Engineering Laboratory, Southwest Environmental Section (Code 1141), Western Division,
Naval Facilities Engineering Command, 1220 Pacific Highway, San Diego, California 92132

SEP 2 1982

NWC China Lake

The following is a report of a complete mineral analysis of water.

Well Water

SOURCE OF SAMPLE

Well 27

DATE SAMPLE COLLECTED

7/27

DATE SAMPLE ANALYZED

7/27 - 8/31/82

ANALYST

Staff

	ppm	epm		ppm	epm
CALCIUM (Ca)	59.2	2.86	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	6.1	.50	BICARBONATE (HCO ₃)	73.2	1.20
SODIUM (Na)	61	2.65	HYDROXIDE (OH)		
POTASSIUM (K)	2.68	0.07	SULPHATE (SO ₄)	69	1.44
			CHLORIDE (Cl)	132	3.72
			NITRATE (NO ₃)	-N	0.9
SUM OF EQUIVALENTS	6.08		SUM OF EQUIVALENTS	6.36	
	ppm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	168		SILICA (as SiO ₂)		36
CALCIUM HARDNESS (as CaCO ₃)	143		FLUORIDE (F)		0.89
MAGNESIUM HARDNESS (as CaCO ₃)	25		BORON (B)		0.30
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe)	total	0.09
METHYL ORANGE ALKALINITY (as CaCO ₃)	60		MANGANESE (Mn)	total	0.02
TOTAL DISSOLVED SOLIDS	Gravimetric	438	COPPER (Cu)	total	0.01
SPECIFIC CONDUCTIVITY (Microhm/cm @ 25°C)		720	SYNTHETIC DETERGENTS (APPARENT ABS)		0.040
HYDROGEN ION CONCENTRATION (pH)		7.80	PHOSPHATE (PO ₄)	total	<0.05
Temperature °F		82-84	Langlier Index		-0.08
pHs		7.88	Ryzner Index	7.96	

PL 7019-15

20716-14

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NWC TP 7019, Supplement

TITLE 22 CHEMICAL ANALYSES

Date of Report: May 1, 1987		Lab Sample ID Number 87741	
Laboratory Name FGL Environmental		Signature Lab Director <i>My Wang</i>	
Name of Sampler Knut Beruldsen		Sampler Employed By	
Date/Time Sample Collected 4/1/87 0900 Hrs.	Date/Time Sample Received at Lab. 4/2/87	Were Holding Times Observed?	
System Name Naval Weapons Center, China Lake		System Number 15-703	
Description of Sampling Point Hose Bibb			
Name/Number of Sample Source Well #27		Station Number	
Date and Time of Sample 8 17 10 14 10 11 10 19 10 10 Y Y M M D D T T T T	Water Type G/S	User ID	Submitted to SWQIS By

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
	Analyzing Agency (Laboratory)		28	
mg/L	Total Hardness (as CaCO ₃)		900	1 8 5
mg/L	Calcium (Ca)		916	6
mg/L	Magnesium (Mg)		927	
mg/L	Sodium (Na)		929	6 4
mg/L	Potassium (K)		937	4
Total Cations meq/L Value:				

mg/L	Total Alkalinity (as CaCO ₃)		410	6 0
mg/L	Hydroxide (OH)		71830	0
mg/L	Carbonate (CO ₃)		445	0
mg/L	Bicarbonate (HCO ₃)		440	7 3
mg/L +	Sulfate (SO ₄)		945	8 0
mg/L +	Chloride (Cl)		940	1 3 6
45 mg/L	Nitrate (NO ₃)		71850	4
1.4-2.4 mg/L	Fluoride (F) Temp. Depend.		951	0 7
Total Anions meq/L Value:				

Std Units	pH (Laboratory)		403	8 1
** umho/cm +	Specific Conductance (E.C.)		95	7 8 0
*** mg/L +	Total Filterable Residue at 180° C (TDS)		70300	3 9 3
UNITS	Apparent Color (Unfiltered)		81	< 5
TON	Odor Threshold at 60° C		86	< 1
NTU	Lab Turbidity		82079	< 0 5
0.5 mg/L +	MBAS		38260	< 0 0 5

* 250-500-600

** 900-1600-2200

*** 500-1000-1500

DMS 8351 (11/86)

87741

MCL Reporting Units		Constituent	T T	Storet Code	Analyses Results					
50	ug/L	Arsenic (As)		1002	<				3	0
1000	ug/L	Barium (Ba)		1007	<				5	0
10	ug/L	Cadmium (Cd)		1027	<					5
50	ug/L	Chromium (Total Cr)		1034	<				3	0
1000	ug/L	Copper (Cu)		1042	<				1	0
300	ug/L	Iron (Fe)		1045	<				1	0
50	ug/L	Lead (Pb)		1051	<				3	0
50	ug/L	Manganese (Mn)		1055	<				3	0
2	ug/L	Mercury (Hg)		71900	<					1
10	ug/L	Selenium (Se)		1147	<					5
50	ug/L	Silver (Ag)		1077	<				3	0
5000	ug/L	Zinc (Zn)		1092					1	0

0.2	ug/L	Endrin	39390						
4	ug/L	Lindane	39340						
100	ug/L	Methoxychlor	39480						
5	ug/L	Toxaphene	39400						
100	ug/L	2,4-D	39730						
10	ug/L	2,4,5-TP Silvex	39045						
Date ORGANIC Analyses Completed			73672						

[illegible]

Gross Alpha, pCi/liter less than 1 ± 1.4

NWC TP 7019, Supplement

COMPLETION OF TESTS
1740 WESTON STREET, SAN DIEGO

Environments Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
13 JULY 1979

TO

Public Works Office, Naval Weapons Center, China Lake

The following is a report of a complete mineral analysis of water Well Water

SOURCE OF SAMPLE

Well 29

DATE SAMPLE COLLECTED	DATE SAMPLE ANALYZED		ANALYST		
4 May 1979	May, June 79		Staff		
	ppm	edm		ppm	edm
CALCIUM (Ca)	22	1.12	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	8.8	0.72	BICARBONATE (HCO ₃)	98	1.60
SODIUM (Na)	39	1.70	HYDROXIDE (OH)		
POTASSIUM (K)	2.4	0.06	SULPHATE (SO ₄)	41	0.85
			CHLORIDE (Cl)	29	0.82
			NITRATE as NO₃ N	< 1	
SUM OF EQUIVALENTS		3.60	SUM OF EQUIVALENTS		3.27
	ppm		RESULTS		
TOTAL HARDNESS (as CaCO ₃)	92		SILICA (as SiO ₂)	31	
CALCIUM HARDNESS (as CaCO ₃)	56		FLUORIDE (F)	0.72	
MAGNESIUM HARDNESS (as CaCO ₃)	36		BORON (B)	0.23	
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) TOTAL	0.035	
METHYL ORANGE ALKALINITY (as CaCO ₃)	80		MANGANESE (Mn) TOTAL	<0.002	
TOTAL DISSOLVED SOLIDS	217		COPPER (Cu) TOTAL	0.024	
SPECIFIC CONDUCTIVITY (Micromhos @ 25° C)	310		SYNTHETIC DETERGENTS (APPARENT ABS)	* -	
HYDROGEN-ION CONCENTRATION (pH)	8.13		PHOSPHATE (PO ₄) TOTAL	<0.03	

REMARKS

* Insufficient sample to run test

#90505-12

NWC TP 7019, Supplement

COMPLETE MINERAL ANALYSIS OF WATER
12ND WESTDIV 11330/18 (276)

FROM: Environmental Engineering Laboratory, Western Division,
Naval Facilities Engineering Command, San Diego, California 92132

DATE
24 APRIL 1980

Naval Weapons Center, China Lake

The following is a report of a complete mineral analysis of water:

WELL

SOURCE OF SAMPLE

Well #29

DATE SAMPLE COLLECTED

29 MAR 80

DATE SAMPLE ANALYZED

29 MAR 80

ANALYST

sr-ff

	ppm	epm		ppm	epm
CALCIUM (Ca)	22	1.10	CARBONATE (CO ₃)		
MAGNESIUM (Mg)	3	0.24	BICARBONATE (HCO ₃)	88	1.44
SODIUM (Na)	42	1.82	HYDROXIDE (OH)		
POTASSIUM (K)	3.6	0.09	SULPHATE (SO ₄)	38	0.79
			CHLORIDE (Cl)	36	1.01
			NITRATE (NO ₃) N	41	-
SUM OF EQUIVALENTS		3.25	SUM OF EQUIVALENTS		3.24
	ppm			RESULTS	
TOTAL HARDNESS (as CaCO ₃)	67		SILICA (as SiO ₂) TOTAL		25
CALCIUM HARDNESS (as CaCO ₃)	55		FLUORIDE (F)		0.74
MAGNESIUM HARDNESS (as CaCO ₃)	12		BORON (B)		0.25
PHENOLPHTHALEIN ALKALINITY (as CaCO ₃)	0		IRON (Fe) TOTAL		0.24
METHYL ORANGE ALKALINITY (as CaCO ₃)	72		MANGANESE (Mn) TOTAL		0.056
TOTAL DISSOLVED SOLIDS	287		COPPER (Cu) TOTAL		<0.01
SPECIFIC CONDUCTIVITY (Micro-mhos @ 25° C)	410		SYNTHETIC DETERGENT (APPARENT ABS)		0.05
HYDROGEN-ION CONCENTRATION (pH)	8.20		PHOSPHATE (PO ₄) TOTAL		0.09

REMARKS

100918-16

NAME AND NUMBER U.S. China Lake Naval Weapon Center 88290
well 29

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

Reporting Units	Constituent	T T	Storet Code	Analyses Results
ug/L	Arsenic (As)		1002	< 3.0
ug/L	Barium (Ba)		1007	5.0
ug/L	Cadmium (Cd)		1027	< 5
ug/L	Chromium (Total Cr)		1034	< 3.0
ug/L+	Copper (Cu)		1042	< 1.0
ug/L+	Iron (Fe)		1045	< 1.0
ug/L	Lead (Pb)		1051	< 3.0
ug/L+	Manganese (Mn)		1055	< 3.0
ug/L	Mercury (Hg)		71900	< 1
ug/L	Selenium (Se)		1147	< 5
ug/L	Silver (Ag)		1077	< 3.0
ug/L	Zinc (Zn)		1092	< 1.0

ORGANIC CHEMICALS

ug/L	Endrin		39390						
ug/L	Lindane		39340						
ug/L	Methoxychlor		39480						
ug/L	Toxaphene		39400						
ug/L	2, 4-D		39730						
ug/L	2, 4, 6-TP Silvex		39045						
Date ORGANIC Analyses Completed			73672						
				Y	Y	M	M	D	D

ADDITIONAL ANALYSES

NTU	Field Turbidity		82078						
C	Source Temperature		10						
	Langelier Index Source Temp.		71814						
	Langelier Index at 60° C		71813						
Std. Units	Field pH		00400						
	Aggressiveness Index		82383						
mg/L	Silica		00955						
mg/L	Phosphate		00650						
mg/L	Iodide		71865						
	Sodium Absorption Ratio		00931						
	Asbestos		81855						
g/L	gross alpha							5	±2.0

+ Indicates Secondary Drinking Water Standards

NWC TP 7019, Supplement

TITLE 22 CHEMICAL ANALYSES

Date of Report <u>April 21, 1987</u>		Lab Sample ID Number <u>88290</u>	
Laboratory Name <u>FGI Environmental</u>		Signature Lab Director <u>[Signature]</u>	
Name of Sampler <u>Knut J. Beruldsen</u>		Sampler Employed By <u>Naval Weapons Center</u>	
Date/Time Sample Collected <u>4/21/87 0900 hrs.</u>	Date/Time Sample Received at Lab.	Were Holding Times Observed?	
System Name <u>U.S. Naval Weapons Center</u>		System Number <u>15-703</u>	
Description of Sampling Point <u>hose bib</u>			
Name/Number of Sample Source <u>Well # 29 (Intermediate well field)</u>		Station Number	
Date and Time of Sample <u>8 7 0 4 2 1 0 9 0 0</u> Y Y M M D D T T T T	Water Type <u>G/S</u>	User ID	Submitted to SWGIS By

MCL Reporting Units	Constituent	T T	Storet Code	Analyses Results
	Analyzing Agency (Laboratory)		28	
mg/L	Total Hardness (as CaCO ₃)		900	5.5
mg/L	Calcium (Ca)		916	1.6
mg/L	Magnesium (Mg)		927	4
mg/L	Sodium (Na)		929	4.6
mg/L	Potassium (K)		937	3
Total Cations meq/L Value:				

mg/L	Total Alkalinity (as CaCO ₃)		410	10.0
mg/L	Hydroxide (OH)		71830	10
mg/L	Carbonate (CO ₃)		445	10
mg/L	Bicarbonate (HCO ₃)		440	12.2
mg/L +	Sulfate (SO ₄)		945	2.8
mg/L +	Chloride (Cl)		940	2.4
45 mg/L	Nitrate (NO ₃)		71850	3
1.4-2.4 mg/L	Fluoride (F) Temp. Depend.		951	0.7
Total Anions meq/L Value:				

Std Units	pH (Laboratory)		403	8.2
** umho/cm +	Specific Conductance (E.C.)		95	35.0
*** mg/L +	Total Filterable Residue at 180° C (TDS)		70300	21.2
UNITS	Apparent Color (Unfiltered)		81	< 5
TON	Odor Threshold at 60° C		86	< 1
NTU	Lab Turbidity		82079	< 0.5
0.5 mg/L +	MBAS		38260	< 0.05

* 250-500-600

** 900-1600-2200

*** 500-1000-1500

DHS 8351 (11/86)

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